MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

TEACHING AND EXAMINATION SCHEME FOR POST S.S.C. DIPLOMA COURSES

COURSE NAME : DIPLOMA IN ELECTRICAL ENGINEERING

COURSE CODE : EC

DURATION OF COURSE : EIGHT SEMESTERS **WITH EFFECT FROM 2013-14**

SEMESTER : SEVENTH **DURATION : 16 WEEKS**

PATTERN : CORRESPONDANCE - SEMESTER **SCHEME : G**

SR. NO	SUBJECT TITLE	abbreviation	SUB CODE	TEACHING SCHEME			EXAMINATION SCHEME									SW (17907)
							PAPER HRS.	TH (1)		PR (4)		OR (8)		TW (9)		
				TH	TU	PR		Max	Min	Max	Min	Max	Min	Max	Min	
1	Microcontroller and Applications	MAA	21005	07	01	24	03	100	40	25#	10	--	--	25@	10	50
2	Energy Conservation & Audit	ACA	21006	07	01	20	03	100	40	--	--	--	--	25@	10	
3	Testing & Maintenance of Electrical Equipments	TME	21007	07	01	24	03	100	40	25#	10	--	--	25@	10	
4	**Elective (ANY ONE)**															
	Illumination Engineering	IEN	21008	07	01	20	03	100	40	--	--	--	--	25@	10	
	Modern Electric Traction	MET	21009	07	01	20	03	100	40	--	--	--	--	25@	10	
	Elements of Industrial Automation	EIA	21010	07	01	20	03	100	40	--	--	--	--	25@	10	
			Total	**28**	**04**	**88**	**--**	**400**	**--**	**50**	**--**	**--**	**--**	**100**	**--**	**50**

TOTAL CONTACT HOURS DURING RESIDENT SESSION: 120 HRS [15 days * 8 hrs per day]

Total Marks **: 600**

@ - Internal Assessment, # External Assessment, ▭ No Theory Examination, #* Online Examination.

Abbreviations: TH-Theory, TU- Tutorial, PR-Practical, OR-Oral, TW- Term Work, SW- Sessional Work

NOTE:

1. HOURS MARKED BY * FOR INTERNAL PRACTICAL EXAMINATION TO BE CONDUCTED AT RESSIDENT SESSION.
2. **ONE TEST OF 25 MARKS** TO BE CONDUCTED AT RESIDENT SESSION AND MARKS TO BE SUBMITTED TO GPDL PUNE.
3. 240 HOURS FOR SELF STUDY AT HOME.
4. ALL PRACTICALS/ORAL EXAMS [EXTERNAL ASSESSMENT INDICATED BY #] TO BE CONDUCTED AT EXAM CENTRE.
5. ORAL EXAMINATION [INTERNAL ASSESSMENT @] TO BE CONDUCTED AT EXAM CENTRE.
6. INTERNAL ASSESSMENT @ OF TERM WORK WILL BE DONE AT RESIDENT SESSION.

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

TEACHING AND EXAMINATION SCHEME FOR POST S.S.C. DIPLOMA COURSES

COURSE NAME : DIPLOMA IN ELECTRICAL ENGINEERING GROUP

COURSE CODE : EG

DURATION OF COURSE : EIGHT SEMESTERS **WITH EFFECT FROM 2013-14**

SEMESTER : SEVENTH **DURATION : 16 WEEKS**

PATTERN : PART TIME - SEMESTER **SCHEME : G**

SR. NO	SUBJECT TITLE	abbreviation	SUB CODE	TEACHING SCHEME			EXAMINATION SCHEME									SW (17907)
							PAPER HRS.	TH (1)		PR (4)		OR (8)		TW (9)		
				TH	TU	PR		Max	Min	Max	Min	Max	Min	Max	Min	
1	Microcontroller and Applications	MAA	21005	03	--	02	03	100	40	25#	10	--	--	25@	10	50
2	Energy Conservation & Audit	ACA	21006	03	--	02	03	100	40	--	--	--	--	25@	10	
3	Testing & Maintenance of Electrical Equipments	TME	21007	04	--	02	03	100	40	25#	10	--	--	25@	10	
4	**Elective (ANY ONE)**															
	Illumination Engineering	IEN	21008	04	--	02	03	100	40	--	--	--	--	25@	10	
	Modern Electric Traction	MET	21009	04	--	02	03	100	40	--	--	--	--	25@	10	
	Elements of Industrial Automation	EIA	21010	04	--	02	03	100	40	--	--	--	--	25@	10	
			Total	**14**	**--**	**06**	**--**	**400**	**--**	**50**	**--**	**--**	**--**	**100**	**--**	**50**

Student Contact Hours Per Week: **22 Hrs.**

THEORY AND PRACTICAL PERIODS OF 60 MINUTES EACH.

Total Marks **: 600**

@ - Internal Assessment, # External Assessment, [ ] No Theory Examination, #* Online Examination.

Abbreviations: TH-Theory, TU- Tutorial, PR-Practical, OR-Oral, TW- Term Work, SW- Sessional Work.

- Conduct two class tests each of 25 marks for each theory subject. Sum of the total test marks of all subjects is to be converted out of 50 marks as sessional work (SW).
- Progressive evaluation is to be done by subject teacher as per the prevailing curriculum implementation and assessment norms.
- Code number for TH, PR, OR, TW are to be given as suffix 1, 4, 8, 9 respectively to the subject code.

Course Name : Diploma in Electrical Engineering

Course Code : EG/EC

Semester : Seventh

Subject Title : Microcontroller and Applications

Subject Code : 21005

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	02	03	100	25#	--	25@	150

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

Use of microcontroller based systems has become dominant in society with broad spectrum of applications ranging from house hold appliances to complex industrial environment. A variety of microcontrollers with several on-chip peripherals are now available at affordable price and future foretells of these devices is continuing to expand.

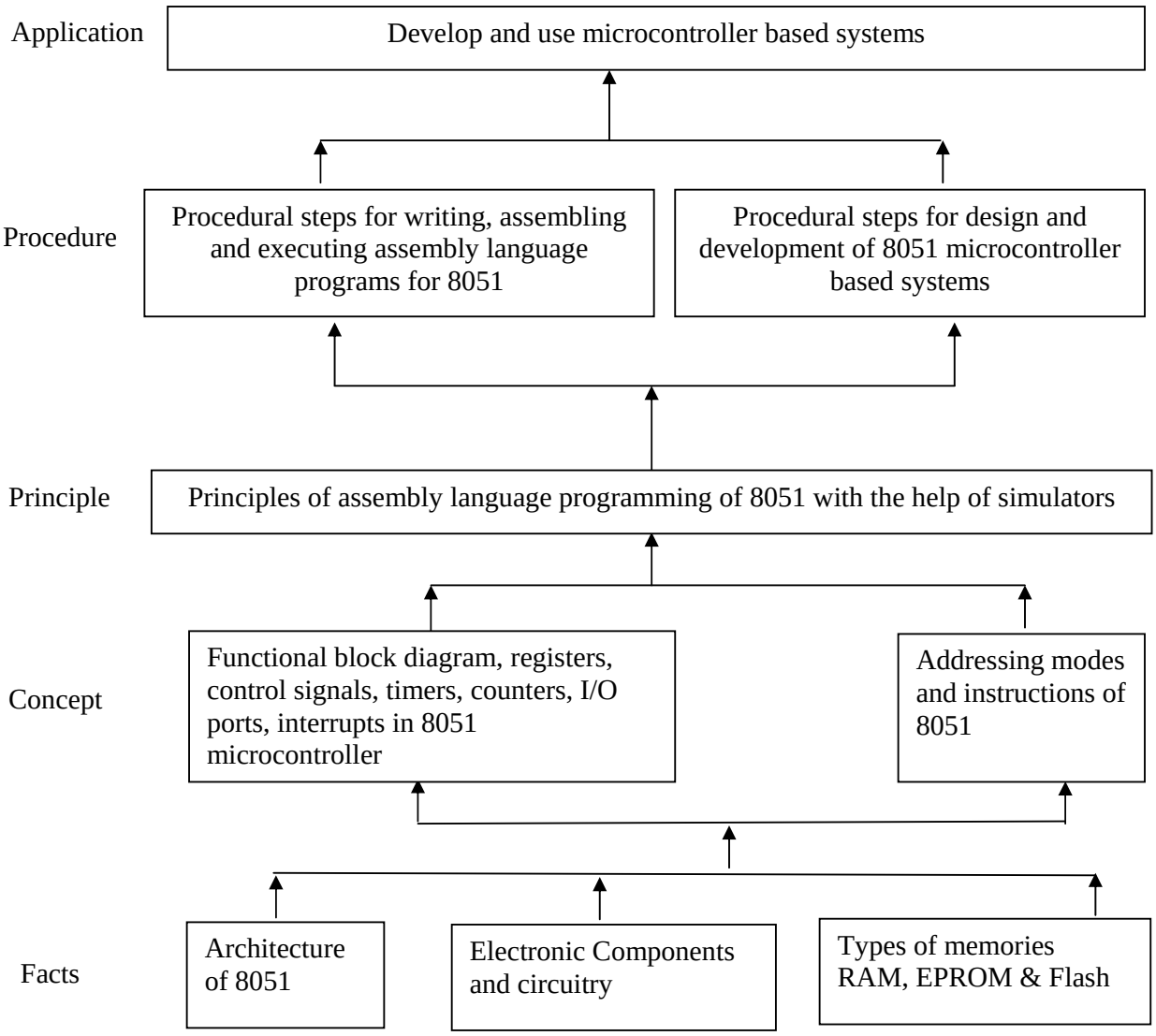
A diploma engineer must have a solid foundation of knowledge of microcontroller based systems, its programming techniques and tools. This will help him in developing innovative solutions to particular industrial problems or to emerge as an entrepreneur.

The low cost, huge range, easy availability and widespread use of the 8051 family makes it an excellent platform for developing microcontroller based systems: these same factors make it an ideal platform for learning about microcontrollers.

General Objectives:

1) Understand 8051 microcontroller architecture.
2) Understand instruction set and assembly language programming
3) Understand the use of higher level language (C programming) to develop programs for 8051 microcontroller.
4) Know the interfacing of various peripherals to 8051
5) Learn basic concepts of system design based on 8051 for typical applications.

Learning Structures:



Contents: Theory

Topic and Contents	Hours	Marks
Topic 1: Introduction to Microcontrollers Specific Objectives: ➢ Convert any number from base 2, base 10, base 16 to either of the two bases. ➢ Describe logical operations AND,OR, NOT, XOR, NAND, NOR ➢ Explain difference between bit, nibble, a byte and a word and definitions of kilobyte, megabyte, gigabyte. ➢ Define terms such as hardware, software, firmware, cpu, bus, ports, operating system. ➢ Explain Harvard and Von Neumann architecture, RISC, CISC machines. **Contents:** 1.1 Digital Primer • Binary, decimal, hexadecimal numbering system and conversion between either of the two bases. • Addition of binary and hex numbers and subtraction using 2's complement. • Review of logic gates: AND, OR, NOT, XOR, NAND, NOR. • Definitions of important terms: bit, byte, nibble, word, kilobyte, megabyte, gigabyte, terabyte. 1.2 Introduction to digital computer • Block diagram of a digital computer, and definitions of terms: Hardware, software, firmware, memory, CPU, address bus, data bus, control bus, ports. • Memory Classification: RAM (static and dynamic), ROM, PROM, EPROM, EEPROM, FLASH. • Microprocessor and features of a microprocessor based system 1.3 Microcontroller basics • Schematic block diagram of a microcontroller. • Comparison between a microcontroller and microprocessor. • Von-neumann and Harward architecture. • RISC and CISC machines. • Features of 8051 microcontroller. • Survey of commercially available 8051 microcontrollers e.g. Atmel, Dallas.	04	08
Topics 2: 8051 Microcontroller Architecture Specific Objectives: ➢ Draw labeled pin diagram and state function of each pin. ➢ Understand system clock characteristics and reset circuit. ➢ Describe the internal memory organization and different special functions register. ➢ Describe the functions of stack pointer and program counter ➢ Describe different interrupt sources, priorities and services. **Contents:** 2.1 Architecture • Block diagram of internal architecture • Pin diagram, function and alternate function of pins • System clock, machine cycles and reset circuit.	12	24

2.2 Memory Organization • Internal program and data memory, external memory interface • Register banks, bit and byte addressable area. • Registers: PC, DPTR, A&B, PSW and other Special function registers(SFR) • Architecture of I/O ports • Stack and stack pointer register 2.2 Timers and Counters. • Timer/counter control logic and interrupts. • TMOD and TCON SFR map. • Timer modes of operation. 2.3 Interrupts. • Interrupt sources. • IE and IP SFR map • Interrupt priorities 2.4 8052 microcontroller • Comparison of 8051 and 8052 microcontroller		
Topic 3: Addressing Modes and Instructions of 8051 **Specific Objectives:** ➢ Explain the instruction syntax and data types. ➢ Explain instruction timings. ➢ Explain the instruction set. ➢ Define subroutines and explain its uses. ➢ Assemble and run simple assembly programs **Contents:** 3.1 Instruction syntax and data types • Opcode, Operand, label, comment, and assembler directives such as DB, ORG, EQU, END • Data types and data range 3.2 Addressing modes • Immediate, register, direct, indirect, indexed, relative, absolute, bit inherent, bit direct. 3.3 Instruction set • Definition of basic parameters: T-State, machine cycle, instruction cycle. • Instructions: data transfer, arithmetic, logical, branching, subroutines, bit manipulation. 3.4 Assembly language programming • Develop assembly language programs for the following commonly used applications. i) Addition, subtraction of two 8 bit, 16 bit signed/unsigned numbers. ii) Multiplication and division on two 8 bit/16 bit unsigned numbers. iii) Find largest and smallest number integer of an array. iv) Average of 8-bit numbers. v) Bubble sorting. vi) Data transfer from one location to other. vii) Programmable delay generation. viii) Program to generate square wave on the port pin using timer. ix) Simple program for demonstrating interrupt service.	12	24

x) Program to measure time period of a square wave using counter. xi) Program to demonstrate use of subroutine.		
Topic 4: 8051 Programming in C Specific Objectives: ➢ Examine C data types ➢ Work with C-compiler and simulator Contents: 4.1 C data types • C data types such as unsigned/signed char, unsigned/signed int, sbit, sfr. • Introduction to integrated development environment such as Keil µ-vision 4.2 C Programming • Writing simple C programs for i) Continuously toggle all bits of a port and particular port pin with some delay. ii) Bit wise shift operation. Left/right port data continuously. iii) Addition of array elements. iv) Read input port and send hex data to output port.	04	12
Topic 5: External Peripheral Interface Specific Objectives: ➢ Interface simple push button switches and output data to LEDs. ➢ Input data from matrix keyboard and output to seven segment display. ➢ Use D/A converter to generate digital/analog waveforms. ➢ Interface 8 bit/12 bit ADC. ➢ Interface character LCD display. ➢ Interface serial port. Contents: 5.1 Reading push buttons • Interfacing of a key or push button, contact bouncing, hardware and software de-bouncing, C program to read valid key status. • Interfacing 3x3 key matrix and C program to store key status. 5.2 LED & LCD interface • Interfacing of LEDs (common anode and common cathode) and multiplexed seven segment LED displays (4 digit), C program • Parallel interfacing of 20x4 character LCD display using 8bit data transfer, C program. 5.3 ADC and DAC interface • Interfacing of 8-channel, 8 bit parallel ADC 0809 and C-program. • Interfacing of MAX 1112 serial ADC, C-Program • Interfacing of 8 bit DAC 0808, C-program. 5.4 Serial port interface • Basics of serial communication: 8bit-UART mode • Overview of serial port registers, SCON, SBUF, SMOD • C program to transmit and receive data serially from personal computer using 8bit-UART mode.	08	16
Topic 6: Typical applications Specific objectives ➢ Develop schematic diagrams for typical applications ➢ Develop flowchart for such applications	08	16

6.1 Interfacing applications (programming not expected) • Temperature measurement using LM35 temperature sensor. • Relay and opto-isolator interface • DC motor speed control • Stepper motor control • Servo motor control		
Total	**48**	**100**

Practical:
Skills to be developed:

Intellectual Skills:

1. Logical thinking process development
2. Programming skills

Motor Skills:

1. Data entry, Error Correction and Execution of assembly language programs
2. Connections

List of Practicals:

1. Develop and Execute Assembly language program for demonstrating basic arithmetic operation.
2. Develop and Execute Assembly language program for demonstrating Bit level operation.
3. Develop and Execute Assembly language program based on an array.
4. Develop and Execute Assembly language program to generate Square wave over port pin.
5. Develop and Execute Assembly language program for demonstrating use of look up table.
6. Develop and Execute 'C' program for I/O operation with port.
7. Develop and Execute 'C' program to Interface 7 Segment LED display.
8. Develop and Execute "C" program to interface 16X2 LCD display.
9. Develop and Execute 'C' program to demonstrate Serial communication.
10. Develop and Execute "C" program to interface Stepper Motor.

Learning Resources:
Books:

Sr. No.	Author	Title	Publisher
1	Kenneth Ayala	The 8051 Microcontroller Architecture Programming and Applications	Penram International Publishing (India). 1996
2	Subrata Ghoshal	8051 microcontroller - internals, instructions, programming and	Pearson

		interfacing	
3	Ajay Deshmukh	8051 microcntroller and applications	Tata McGraw Hill
4	M. Mazidi et al.	The 8051 Microcontroller and Embedded Systems - using assembly and C	Pearson
5	K. Uma Rao	The 8051 Microcontroller - Architecture, Programming and Applications	Pearson
6	V. Udaysankara et al.	8051 microcontroller - Hardware, Software and Applications	McGraw Hill
7	J. S. Parab et al.	Exploring C for microcontrollers- A hands on approach	Springer

Websites:

1. www.keil.com
2. www.8052 .com
3. www.MicroDigitalEd.com
4. www.8051projects.net

Course Name : Diploma in Electrical Engineering

Course Code : EG/EC

Semester : Seventh

Subject Title : Energy Conservation and Audit

Subject Code : 21006

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	02	03	100	--	--	25@	125

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

Technological development in all sectors has caused imbalance in energy generation and it's consumption. Energy conservation is a scientific tool provided to minimize the energy imbalance. This is one of the rapid emerging field in the area of electrical engineering hence this has been included as core technology subject.

The contents on energy conservation techniques in lighting systems, motors, transformers and transmission - distribution lines will be useful to reduce energy losses and wastage in residential, commercial and industrial sectors.

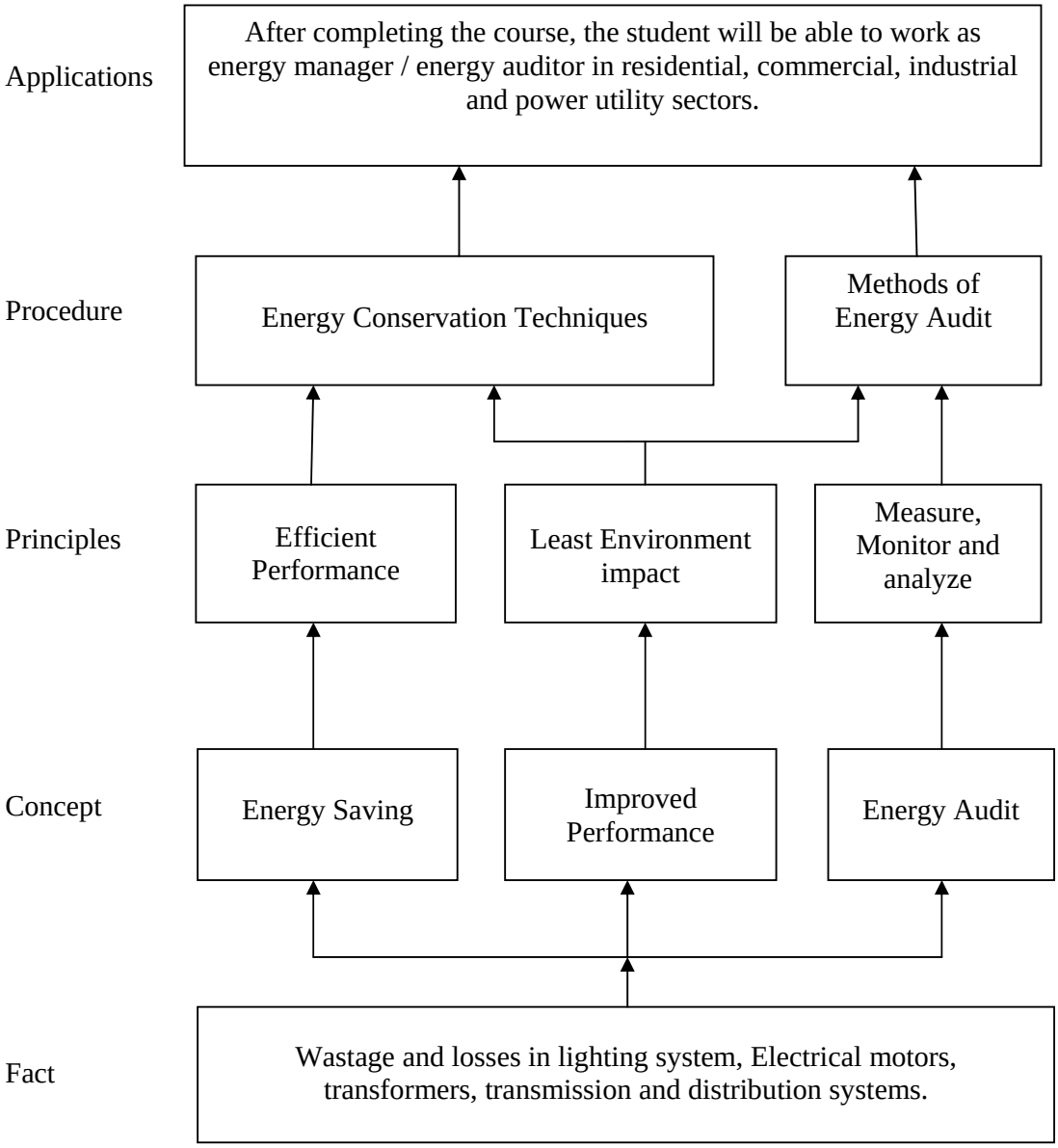
The topic on energy audit will be an useful tool to participate in energy conservation program of the nation.

General Objectives:

The students will be able to:

1. Identify the energy losses and wastage.
2. Suggest the energy conservation techniques in various sectors.
3. Find the opportunity for saving in energy consumption through tariff structure.
4. Prepare energy audit report.

Learning Structure:



Theory:

Topic and Contents	Hours	Marks
Topic 1 : Energy Conservation **Specific Objectives:** ➢ Identify the need of Energy Conservation. ➢ State functions of Government organization working for ECA. **Contents:** 1.1 Preset energy scenario. 1.2 Need of energy conservation. 1.3 State the meaning of term Energy Conservation. 1.4 Energy Conservation Act – 2003. 1.5 Functions of Government Organization (NPC, MNRE, BEE, MEDA).	02	04
Topics 2: Energy Conservation in Lighting System **Specific Objectives:** ➢ Assess existing lighting system ➢ Identify energy conservation techniques in lighting system. ➢ Suggest methods to improve energy conservation **Contents:** 2.1 Basic terms used in Lighting system (Illumination). 2.2 Recommended Luminance levels 2.3 Procedure for assessing existing Lighting system in a facility. 2.4 Energy Conservation techniques in lighting system. • By replacing Lamp sources. • Using energy efficient luminaries. • Using light controlled gears. • By installation of separate transformer / servo stabilizer for lighting. • Periodic survey and adequate maintenance programs. • Energy Conservation techniques in fans, Electronic regulators.	06	12
Topic 3 : Energy Conservation techniques in Electrical Motors **Specific Objectives:** ➢ Select electrical motors for suitable application. ➢ Energy conservation techniques for improving the performance of motor by various methods. **Contents:** 3.1 Construction, Power flow and working of Induction motor. 3.2 Factors governing the selection of Induction motor. 3.3 Need for energy conservation in Induction motor. 3.4 Various energy conservation techniques in Induction motor. • By improving Power quality. • By motor survey.	06	14

• By matching motor.
• By minimizing the idle and
  o Redundant running of motor.
• By operating in star mode.
• By rewinding of motor.
• By improving mechanical
  o power and transmission
  o Efficiency.
3.5 Energy Efficient motors.
 	
• Comparison with conventional Induction motor		

Topic 4: Energy Conservation techniques in transformer **Specific Objectives:** ➢ List out the methods to improve performance of transformer. ➢ Suggest energy conservation techniques to improve transformer performance **Contents:** 4.1 Need of energy conservation in transformer. 4.2 Methods (related to material, design) to improve the performance of transformer. 4.3 Energy conservation techniques related to transformer. • Loading sharing • Parallel operation • Isolating techniques 4.4 Energy efficient transformers. • Amorphous transformers • Epoxy Resin cast transformer (Dry type of transformer). • Periodic maintenance.	04	08

Topic 5: Energy conservation in transmission and distribution system.
Specific Objectives:
 	
➢ State scenario of losses in transmission and distribution system
➢ Identify Energy conservation opportunities
➢ Suggest methods for energy conservation.
 	
Contents:
5.1 Scenario of transmission and distribution losses at state level, national level and at global level.
5.2 Types of losses in transmission and distribution system (commercial and technical losses)
5.3 Energy conservation techniques in transmission and distribution system related to technical losses.
• By reducing I^2R losses.
• By compensating reactive power flow.
• By optimizing distribution
  o voltage
• By balancing phase currents.
• By using energy efficient
  o Transformers
5.4 Energy conservation techniques related to commercial losses.
	06	12

Topic 6: Relation Between Tariff And Energy Conservation. **Specific Objectives:** ➢ Identify the opportunities to reduce energy bill through selection of tariff structure ➢ Select appropriate tariff structure to reduce energy bill **Contents:** 6.1 Types of tariff structure. 6.2 Terms involved in tariff. 6.3 Specific tariff: • Time-off-day tariff • Peak-off-day tariff • Power factor tariff • Maximum Demand tariff • Load factor tariff 6.4 Application of tariff system to reduce energy bill. 6.5 Simple numerical based on power factor and load factor tariff.	06	14
Topic 7: Energy Conservation by Cogeneration **Specific Objectives:** ➢ Classify cogeneration systems. ➢ Selection of appropriate cogeneration system to reduce energy bill **Contents:** 7.1 What is cogeneration? 7.2 Need for cogeneration. 7.3 Classification of cogeneration system on the basis of sequence of energy use. • Topping cycle • Bottoming cycle 7.4 Classification of cogeneration system on the basis of technology. • Steam turbine cogeneration. • Gas turbine cogeneration • Reciprocating engine cogeneration. 7.5 Factors governing the selection of cogeneration system. 7.6 Advantages of cogeneration.	04	12
Topic 8: Energy Conservation Equipment **Specific Objectives:** ➢ List out energy conservation equipments. ➢ Select proper energy conservation equipments in various applications. **Contents:** 8.1 What is energy conservation equipment? 8.2 Energy conservation equipment related to Lighting system. • Centralized Control Equipment (Microprocessor based). • Occupancy sensors/Motion Detectors. • Control gears: Dimmers, Regulators, and Stabilizers). 8.3 Energy conservation equipment related to electrical motors: Construction, working and advantages of each energy conservation	06	12

Equipment listed below: • Soft starter: For induction motors • Power Factor Controller • Static capacitor • Automatic star delta starter • Variable Frequency Drives. 8.4 Energy conservation equipments in T&D system: Working principle and operation of • Maximum Demand Controller • KVAR Controller • Automatic Power Factor controller.		
Topic 9: Energy Audit **Specific objectives:** ➢ Select energy audit instruments. ➢ Prepare/Develop questionnaire for energy audit. ➢ Apply ABC analysis in energy projects. ➢ Calculation of simple pay back period. ➢ Write energy audit report. **Contents:** 9.1 Energy flow diagrams and its significance. 9.2 Energy audit instruments and their use. 9.3 Prepare questionnaire for energy audit projects. 9.4 ABC analysis and it's advantages referred to energy audit projects. 9.5 Energy Audit procedure (walk through audit and detailed audit). 9.6 Calculation of simple pay back period (Simple numerical)	08	12
Total	**48**	**100**

List of Assignments:

1. Collect the information about energy conservation act from IEE 2003.
2. Prepare a write up on role of Energy Manager and Energy Auditor.
3. Collect of information by market survey and prepare report on rating, luminous output, cost, list of manufacturers of various types of energy efficient luminaries (FTL, CFL, LED, Sodium Vapour, HPMV etc.)
4. Make a comparative study of energy efficient control gears and ballasts used in lighting system on the basis of energy efficiency, cost, life, energy saving and saving in energy bill
5. Visit to any organization where energy conservation program is implemented (Hospitals, workshops, institutes, commercial building, residential building etc.)
6. Using various energy audit instruments used for measurement of electrical, mechanical and thermal energy parameters, carryout energy audit and prepare a report as a case study for Residence, Small workshop, Public Library, Hospital etc.

Learning Resources:

1. Books:

Sr. No.	Author	Title	Publisher
1	S. Sivanagraju M. Balasubba Reddy D. Srilatha	Generation And Utilization Of Electrical Energy	Pearson, New Delhi

2	P. H. Henderson	India - The Energy Sector	University Press
3	W. C. Turner	Energy Management Handbook	Wiley Press
4	B. G. Desai J. S. Rana A. V. Dinesh R. Paraman	Efficient Use And Management Of Electricity In Industry	Devki Energy Consultancy PVT. Ltd.

2. Websites:

1. Website of bureau of energy and efficiency : www.bee-india.nic.in
2. Website of Akshay Urja News Bulletin : www.mnes.nic.in
3. Notes on energy management on : www.energymanagertraining.com
4. www.greenbusiness.com
5. www.worldenergy.org

Course Name : Diploma in Electrical Engineering

Course Code : EG / EC

Semester : Seventh

Subject Title : Testing and Maintenance of Electrical Equipments

Subject Code : 21007

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
04	--	02	03	100	25#	--	25@	150

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

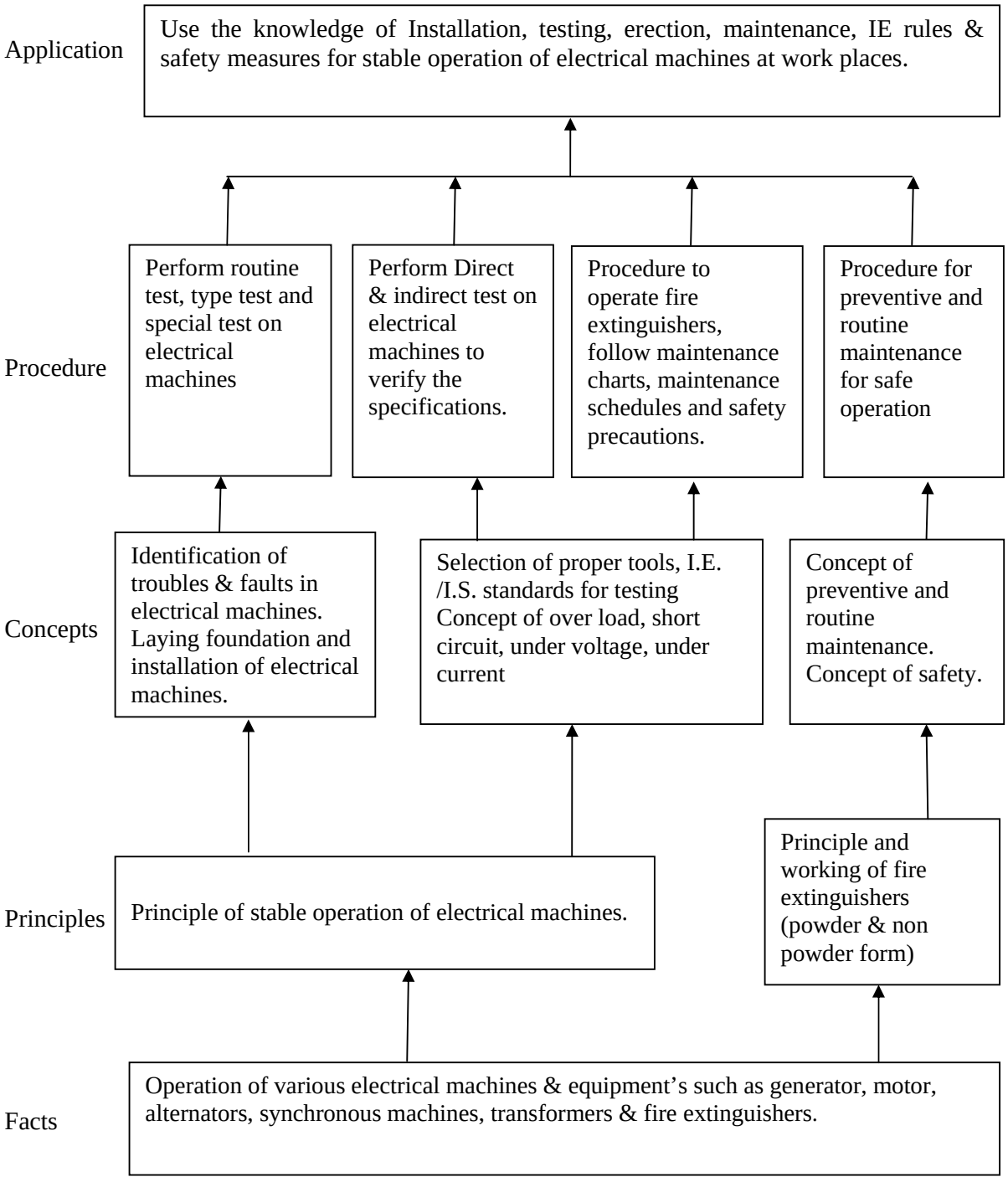
This course is under applied technology courses. Most of the diploma electrical engineers are working either in industries, power plants or in state electricity board as a supervisor / technician/procurement engineer. They have to understand instructions from superiors and pass on the same to the skilled workers working under them. The knowledge of testing, maintenance, erection and installation of electrical equipment's in industries, power plants and state electricity board is essential. This subject provides the detailed guidelines as per I.S. codes/I.E. Rules for testing, maintenance, erection and installation of electrical equipment's. As scope of business/Industry is at global level it is also essential that the student should be well conversed about international codes. They should be made aware about importance of preventive maintenance for efficient and effective functioning of electrical machines.

General Objectives:

After completing this course students will be able to-

1. Know I.S. codes/I.E. Rules & safety measures related to electrical machines.
2. Identify / Locate common troubles in electrical machines.
3. Plan & carry out routine & preventive maintenance
4. Prepare trouble-shooting charts for electrical machines.
5. Ascertain the condition of insulation & revarnishing if necessary.
6. Initiate total productive maintenance.

Learning Structure:



Theory:

Topic and Contents	Hours	Marks
Topic 1: Safety Measures & Prevention of Accidents Specific Objectives: ➢ To follow electrical safety measures ➢ To rescue electrocuted person and follow artificial respiration methods ➢ To use fire extinguisher for fire due electrical causes Contents: 1.1 Concept of electrical safety, electrical accidents, its causes & preventions. 1.2 Safety signs and symbols used in industry. 1.3 Electrical shocks and factors affecting the severity of it, method of rescuing electrocuted person & different methods of artificial respiration. 1.4 Electrical safety as per I.E. Rules 1956. 1.5 Do's & don'ts regarding safety while working on electrical installations. 1.6 Concept of Permit system, its preparation & regulation for attending to electrical work. 1.7 Precautions to be taken to avoid fire due to electrical reasons, operation of fire extinguishers, types of fire extinguishers.	08	12
Topic 2: Testing of Electrical Machines Specific Objectives: ➢ To perform tests on various electrical machines as per Indian Standards Contents: 2.1 Objectives of testing. 2.2 Roles of Bureau of Indian Standards (BIS) in testing of electrical equipment's. 2.3 Types of tests: Routine, type, supplementary & special tests. 2.4 Methods of testing - Direct/ Indirect/ Regenerative testing. 2.5 Concepts of tolerances. • Tolerances for rotating machines as per IS 4722-2001 • Tolerances for power transformers as per IS 2026 (part-I) - 2011 2.6 Testing of transformer as per IS 2026 (Part-I)-2011 • Routine tests, Type tests and Special tests. 2.7 Testing of three-phase Induction motor as per IS 4029 - 2010 and IS 325 - 1996. • I.M. as a generalized transformer with vector diagram • Equivalent circuit of 3-phase IM (No numerical) • performance of open circuit test and short circuit (blocked rotor) test to find various quantities by drawing circle diagram with various conditions such as • at full load • maximum torque • maximum output • maximum input 2.8 Numericals on 2.6 & 2.7. 2.9 Testing of single-phase induction motor as per IS 7572-2009. 2.10 Testing of synchronous machines as per IS 7132-1973.	22	32

Topic 3: Maintenance of Electrical Machines Specific Objectives: ➢ To plan routine and preventive maintenance schedule ➢ To prepare maintenance schedules for electrical equipments as per IS ➢ To identify different faults developed due to poor maintenance of electrical machines Contents: 3.1 Concept of maintenance, types of maintenance, Routine, preventive & breakdown maintenance. 3.2 Causes of failure of electrical machines. 3.3 Preventive maintenance • Advantages • Procedure for developing preventive maintenance schedules for electrical machines 3.4 Factors affecting preventive maintenance schedules. 3.5 Identification of different types of faults developed such as mechanical, electrical and magnetic faults due to poor maintenance. 3.6 Maintenance schedules of the following as per I.S.S. • Distribution transformer and Power transformer as per IS 10028 (Part-III)-1981 • Single phase & three phase Induction motors as per IS 900-1992 • Synchronous machines • Batteries IS 14782-2000	10	12
Topic 4: Testing and Reconditioning of Insulating Materials Specific Objectives: ➢ To follow the methods of reconditioning of insulation ➢ To test insulating oil as per IS ➢ To measure insulation resistance by different methods Contents: 4.1 Factors affecting life of insulating materials, classifications of insulating materials as per IS 1271-1985. 4.2 Measuring insulation resistance by different methods such as i) Polarization, ii) Dielectric absorption, iii) Megger • To predict the condition of insulation • Meaning of infinity and zero reading 4.3 Reconditioning of insulation • Cleaning and drying the insulation • Re-varnishing • Construction and working of vacuum impregnation plant 4.4 Insulating oil • Properties of insulating oil • Causes of deterioration of oil • Testing of transformer oil as per IS 1866-2000 • Method of purification and filtration of insulating oil	08	16
Topic 5: Fault Finding and Troubleshooting of Electrical Machines Specific Objectives: ➢ To use various tools for fault finding in electrical machines ➢ To locate faults in electrical machines ➢ To prepare trouble shooting charts for rotating machines and	08	12

transformers Contents: 5.1 Limits of voltage, current, frequency & speed for safe working of electrical machines. 5.2 Internal & external causes for failure and abnormal operation of equipments. 5.3 List of mechanical faults, electrical faults & magnetic faults in the electrical equipments. 5.4 Use of tools like bearing puller, filler gauges, dial test indicator, spirit level, megger, earth tester, and growler. 5.5 Common troubles in electrical equipments and machines. Preparation of trouble shooting charts for • D.C. Machines • AC Machines • Transformers [IS 10028 (Part-III) - 1981]		
Topic 6: Installation and Earthing of Electrical Machines Specific Objectives: ➢ To install static and rotating electrical machines ➢ To use the devices and tools for handling of electrical equipments ➢ To level and align different coupled drives ➢ To reduce the resistance of earth electrode by different methods Contents: 6.1 Concept of foundation for machinery installation. Requirements of foundation for static & rotating electrical machinery. 6.2 Concept and procedure of leveling & aligning. • Alignment of direct coupled drive • Effects of misalignment 6.3 Installation of transformer as per IS 10028 (part-II) -1981. 6.4 Requirements of installation of pole mounted transformer. 6.5 Requirements of installation of rotating electrical machines as per IS 900 – 1965 6.6 Devices and tools required for loading, unloading, lifting, and carrying heavy electrical equipment's & precautions to be taken while handling them. 6.7 Earthing • Importance of earthing • Difference between installation earthing & system grounding • Types of earthing as per IS 3043 - 1987 • Earthing resistance values for different types of installations • Factors affecting earth resistance • Methods of reducing earth resistance • Provision of earthing as per I.E. rule-61 & I.E.rule-90	08	16
Total	**64**	**100**

Practical:
Skills to be developed:

Intellectual Skills: 1. Select appropriate meters and equipment.
2. Recollect testing and maintenance procedures.

Motor Skills: 1. Accuracy of measurement.
2. Proper connections.
3. Draw characteristics.

List of Practicals:

Sr. No.	Title of Practical/Lab.Work/Assignments
1	Measure Impedance, Voltage and Load losses of Three phase Transformer.
2	Perform reduced voltage running up test on Three Phase Induction Motor as per IS 325:1967.
3	Perform No Load and Blocked Rotor Test on Three Phase Induction Motor as per IS 325:1967. And Draw Circle diagram and Calculate performance Indicator.
4	Calculate Regulation and Efficiency bye Back to Back connection of single phase Transformer.
5	Determine Breakdown Strength of Transformer Oil by using Oil Testing Kit.
6	Measure Insulation resistance of Transformer winding , Stator and Rotor of A.C. Rotating Machines using Megger.
7	Measure the Resistance of Earth Electrode using Earth Tester.
8	Understand the operation of Fire Extinguisher by giving Demonstration.
9	Prepare Troubleshooting Charts for Single Phase and Three Phase Induction Motor
10	Use different maintenance tools such as Bearing Puller, Growler, Dial-Test Indicators, Filler Gauge, Spirit Level, etc.

List of Assignments:

1. To demonstrate artificial respiration methods for shock affected persons.
2. To visit transformer repairing workshop/ electrical machine workshop.

Learning Resources:

1. **Books:**

Sr. No.	Author	Title	Publisher
1.	B.V.S. Rao	Operation & Maintenance of Electrical Equipments Vol-I & II	Media promoters and publisher Ltd. Mumbai
2.	M.V. Deshpande	Design & Testing of Electrical Machines	PHI learning private Ltd. New Delhi
3.	Sunil S. Rao	Switchgear & Protection	Dhanpat Rai and Sons, New Delhi
4.	Bhattacharya	Electrical Machines	Tata McGraw Hill
5.	V.K. Mehata & Rohit Mehata	Principles of Electrical Machines	S. Chand & Company Ltd.
6.	Tarnekar & Kharbanda	Laboratory Experiments in Electrical Engineering.	S. Chand & Company Ltd.
7.	B. L.Theraja	A Textbook of Electrical Technology Vol.-II	S. Chand & Company Ltd.
8.	Edward Hughes	Electrical and Electronics Technology	ELBS publications
9.	Kothari & Nagrath	Electrical Machines	Tata McGraw Hill

2. **CDs, PPTs, Models, Charts etc. :**
   PPTs:
   - www.lanl.gov/safety/electrical/docs/skilled_worker_module_6.ppt
   - www.sandia.gov/.../Electrical/Sand_2009_1947_P_Non-Electrical

3. **IS Codes and I.E Rules:**

I.E. Rules 1956	: Safety
IS 4722-2001	: Rotating Electrical Machines – Specification
IS 2026 (part-I) -2011	: Power transformers: Part 1 General
IS 2026 (Part-II)-2010	: Power transformers: Part 2 Temperature-rise
IS 2026 (Part-III)-2009	: Power Transformers: Part 3 Insulation Level, Dielectric Tests and External Clearances in Air
IS 2026 (Part-IV)-1977	: Power transformers: Part 4 Terminal marking, tappings and Connections
IS 4029 – 2010	: Guide for testing three-phase induction motors
IS 325-1996	: Three phase Induction motors- specifications
IS 7572-1974	: Guide for testing single-phase ac and universal electric motors
IS 7132-1973	: Guide for testing synchronous machines
IS 10028 (Part-III)-1981	: Code of practice for selection, installation and maintenance of transformers: Part 3 Maintenance
IS 900-1992	: Code of practice for installation and maintenance of induction motors (first revision)
IS 1271-1985	: Thermal evaluation and classification of electrical insulations
IS 1866-2000	: Code of practice for electrical maintenance and supervision of mineral insulating oil in equipment
IS 3043 – 1987	: Code of practice for earthing
IS 15429-2004	: Storage installation and maintenance of dc motors-code of Practice
IS 9320-1979	: Guide for testing d.c. machines
IS 14782-2000	: Code of Practice for Maintenance and Testing of Large Lead acid Batteries for Generating Stations and Substations
I.E. rule-61	: Earthing
I.E.rule-90	: Earthing

4. **Websites:**
   - www.bis.org.in
   - www.standardsbis.in
   - www.civilengineer.co.in

Course Name : Diploma in Electrical Engineering

Course Code : EC / EG

Semester : Seventh

Subject Title : Illumination Engineering

Subject Code : 21008

Teaching and Examination Scheme

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
04	--	02	03	100	--	--	25@	125

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

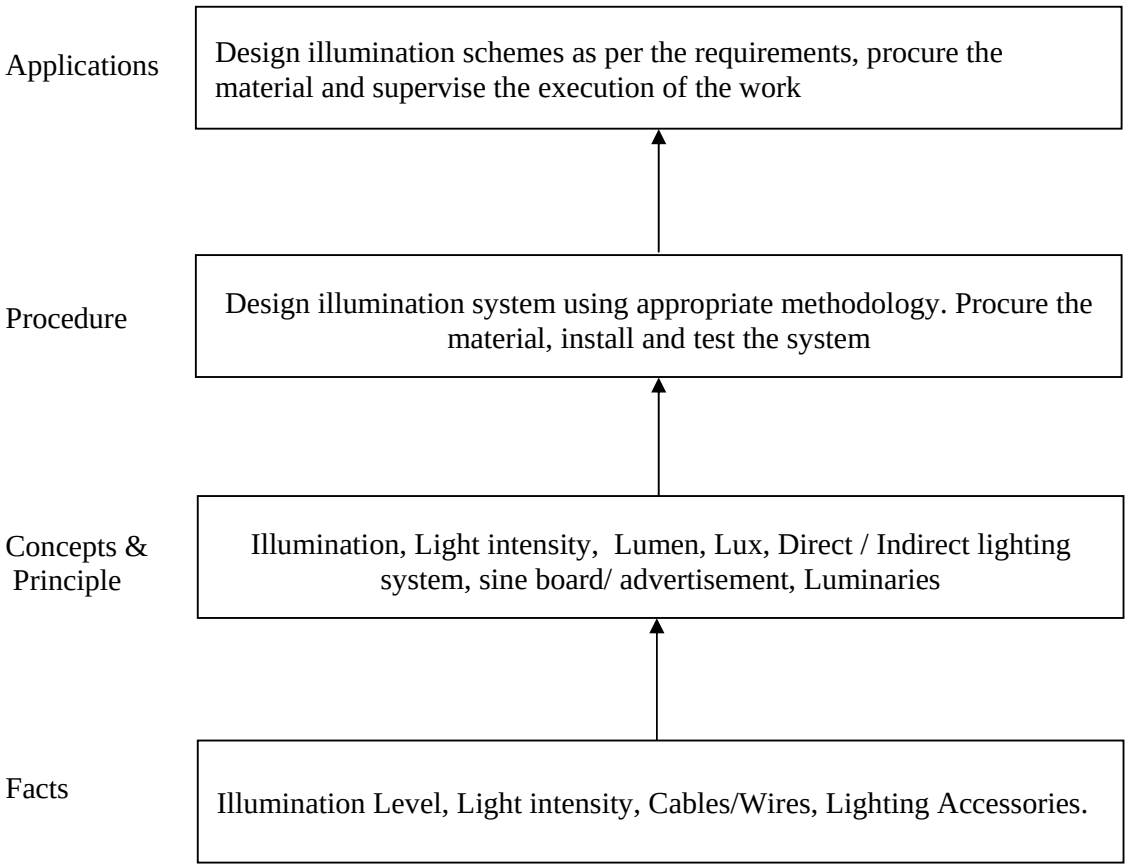
This subject is included to teach the students various aspects of illumination and illumination schemes. Students will be able to apply principles & laws of illumination. Students will have the knowledge of various types of lamps, lighting accessories & control circuit and their applications. He/she will become aware of his/her role in designing and installing illumination equipment as per new illumination trends. With changing life style and interest in recent trends in illumination, there is vast scope for illumination engineers to innovate and cater to the needs of domestic, commercial and industrial consumers. With experience one can start own business in the field of illumination engineering.

General Objectives:

The Students will be able to:

1. Understand the meaning of the terms used in illumination engineering
2. Realise the requirements of various types of consumers
3. Study requirements of illumination levels for various applications.
4. Understand the requirements of illumination equipment and accessories for different applications

Learning Structure:



Theory:

Topic and Contents	Hours	Marks
Topic 1. Fundamentals of Illumination **Specific Objectives** ➢ Identify and measure the level of illumination ➢ Design illumination schemes ➢ Use IEI standards for illumination schemes • Fundamentals of Illumination • Illumination terminology: Illumination, Light intensity, Lumen, Lux • Laws of Illumination (Simple numerical) • Features of good Illumination scheme • Advantages of good Illumination scheme	06	08
Topic 2. Lamps & Lighting Accessories **Specific Objectives** ➢ Differentiate between the various types of lamps. ➢ Collect technical data of lamps and lighting accessories ➢ Identify mountings arrangement for light sources • Types of lights: a. Visible light b. Ultraviolet light c. Infrared light • Types of lamps: a. Incandescent lamp b. ARC lamps – ac &dc arc lamp c. Fluorescent lamp d. Mercury vapour lamp , HPMV lamp, Mercury iodide lamp e. Sodium vapour lamp f. Neon lamp , Neon Sign Tubes g. Halogen lamp h. CFL Lamps i. Metal halides lamp j. LED lamps k. Special purpose lamps • Construction, working principle advantages and disadvantages of all lamps • Comparison between incandescent & Florescent lamps • Lighting schemes: selection of lamp, illumination efficiency , glare & power consumption a. Direct & Indirect b. Semi direct & semi indirect c. General lighting scheme • Lighting calculation methods a. Watt /m2 method b. Lumens or light flux method c. Point to point method (Simple numerical)	12	20
Topic 3. Illumination Control & Control Circuits **Specific Objectives** ➢ Select controlling methods of brightness/colour of light source as per requirements	10	16

➢ Select proper light source as per application ➢ Design control circuit for illumination. • Purpose of lighting control • Working principle and operation of : • Dimmer - a. Resistance type dimmer b. Salt water dimmer Dimmer Transformer 1) Auto transformer dimmer 2) Two winding transformer dimmer • Electronic Dimmer : working principle and operation a. Thyrister operated dimmer b. Triac operated dimmer • Control of Enhance Lighting • Methods used for light control : • Control circuits for lamps : single lamp controlled by single switch, two switches, • Single Lamp control by two point method , three point method & four point method • Polar curve : its meaning and applications for designing the lamps		
Topic 4. Illumination for Interior Applications **Specific Objectives** ➢ Select lux level required for every working plane as per application ➢ Calculate total lux level required for the working plane ➢ Selection to proper light source • Standards for various situations in Interior Illumination • Methods for Designing illumination schemes • Design considerations for Interior location of Residential Commercial, Industrial premises • Design Illumination scheme for different Interior locations of Residential, Commercial, Industrial unit • Numerical on above sub topics	12	20
Topic 5. Illumination for Outdoor Applications **Specific Objectives** ➢ Select proper wattages for light source as per its illumination efficiency ➢ Locate specific mountings of lighting sources for outdoor applications ➢ Consider effect of environmental conditions for working hours of light sources • General requirements for lighting schemes Specific requirements for above schemes • Factory Lighting • Street Lighting • Flood Lighting • Railway platform Lighting • Lighting for Advertisement/Hoardings • Sports Lighting • Simple numerical based on design of simple schemes	12	20
Topic 6. Lighting for Special Applications **Specific Objectives**	12	16

➢ Understand use of special purpose lamps. ➢ Select proper lamps in order to save energy. • Lighting schemes and general requirements for : • Agricultural & Horticultural applications • Health Care Centers and Hospitals • decorative lighting • stage lighting • Aquariums & Shipyards		
Total	**64**	**100**

Practicals:

Intellectual Skills:

1. Apply different designing skill.
2. Select proper equipment.

Motor Skills

1. Measurement of illumination.
2. Drawing skill.

List of Assignments:

1. Estimate and compare luminous efficiency of incandescent and compact fluorescent lamp.
2. Compare performance of magnetic and electronic ballast. Estimate the energy saving with electronic ballast.
3. Understand energy efficient illumination equipments.
4. Design illumination scheme for any one of the following. (A)Flat (B)Bunglow (C)Row House and similar
5. Design illumination scheme for any one of the following. (A) Mall (B) Cloth shop (C) Restaurant (D) Showroom.
6. Write a report on illumination scheme used in industry by visiting small or medium industry.
7. Conduct illumination assessment in workplace using luxmeter
8. Understand biological implication of artificial illumination.

Learning Resources:

1. **Books:**

Sr. No.	Name of the Author	Title of the Book	Name of the Publisher
1.	N. V. Suryanarayana	Utilisation of Electrical Power	Wiley Eastern Limited
2.	Jack l. Lindsey	Applied illumination engineering	The Fairmont Press Inc.
3.	R.H. Simons& Robart Bean	Lighting Engineering & applied calculations	Architectural Press (ISBN0750650516)

2. ISO, IS, BS standards, Data Sheets, IE Rules Handbook
   IS 2418, 9974, 9900, 2218, 5077, 4012, 4013, 1885, 1947, 4347, 6665, 3287, 1777, 3646, 2672, 10894, 1944, 10322, 2140

3. www.onlinefreeebooks.net
   www.ies.org/shop/
   www.opticalres.com/lt/illuminationfund.pdf

Course Name : Diploma in Electrical Engineering

Course Code : EC / EG

Semester : Seventh

Subject Title : Modern Electric Traction

Subject Code : 21009

Teaching and Examination Scheme

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
04	--	02	03	100	--	--	25@	125

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

In these days electric traction is used for mass transport of goods and passengers over short and long distances at faster rate. In electric traction, electric motors are used to propel different vehicles like trolley bus, tram car, electric trains and the latest vehicles that include metro trains, sky bus and mono rail.

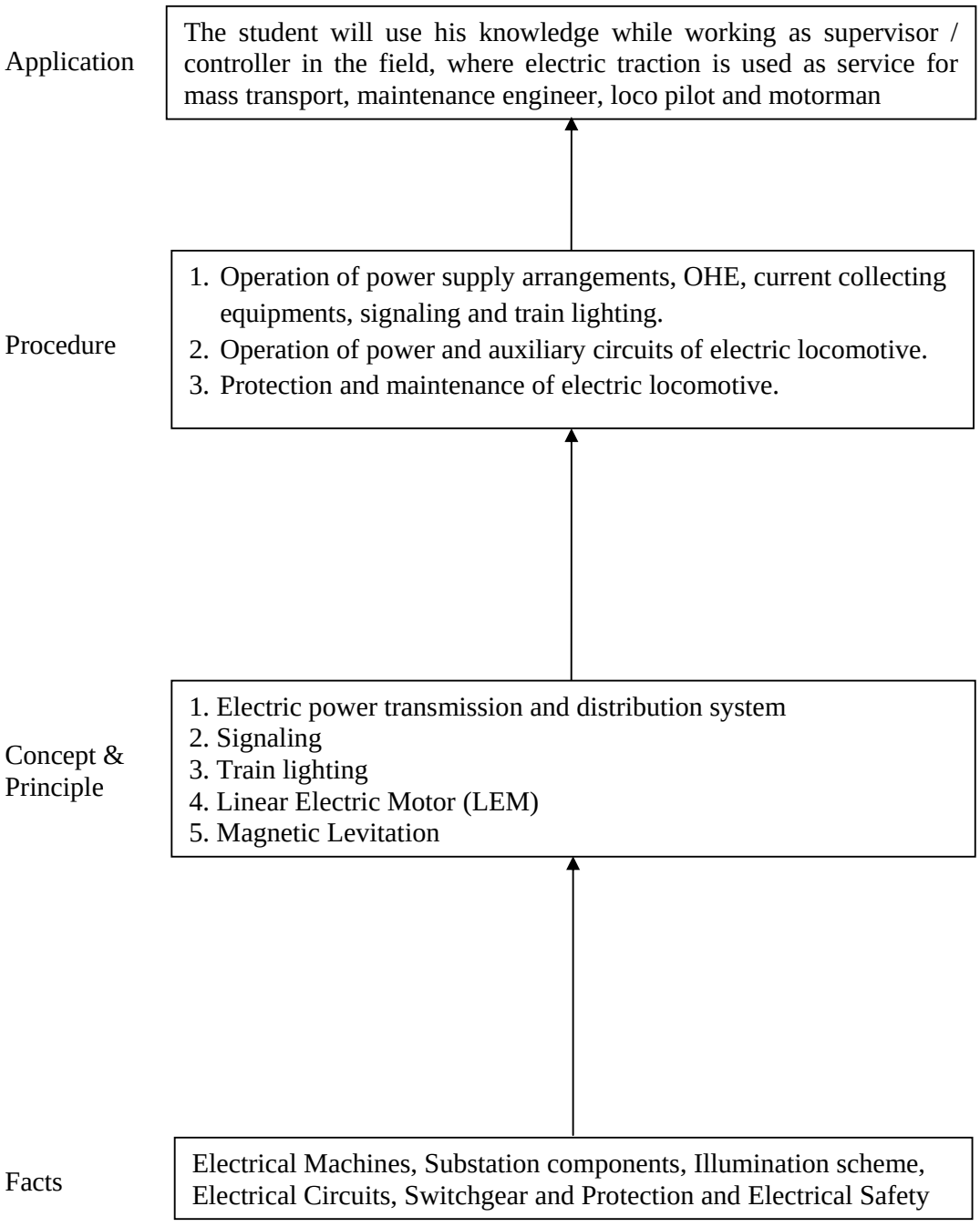
Indian Railways (IR) is the largest organization that has very large job potential and opportunities for electrical engineering diploma holders; hence they should know the recent technological developments in this area of electric traction. This has made it essential for electrical engineering diploma student to study the subject; completely dedicated to electric traction.

General Objectives:

Students will be able to

1) Identify and describe the use of components of power supply arrangements for electric traction
2) Know different overhead equipment's
3) Compare the different type of current collecting systems and current collecting gears
4) Explain various types of signals and track circuits
5) Describe supervisory control used in electric traction
6) Know special requirements of train lighting system
7) Understand the importance of electric locomotive maintenance and protective system
8) Describe the recent trends in electric traction- LEM propelled traction, Metro Rail System, Mono Rail System

Learning Structures:



Theory:

Topic and Contents	Hours	Marks
Topic 1: Power Supply Arrangements Specific Objectives: ➢ Interpret the layout of traction power supply arrangement, ➢ Draw layout of traction power supply arrangement, and ➢ Explain the functions of various constituents of traction power supply arrangement Contents: (Scope – To be restricted as per allotted time and marks) 1.1 Introduction to Traction Supply System 1.2 Constituents of Supply System. • Substations • Feeding Posts. • Feeding and Sectioning Arrangements. • Sectioning and Paralleling Post. • Sub Sectioning and Paralleling Post. • Sub Sectioning Post • Elementary Section. 1.3 Miscellaneous Equipments at Control Post or Switching Stations. 1.4 Major Equipments at Substation • Transformer. • Circuit Breaker. • Interrupter. 1.5 Protective System for AC Traction • Transformer • 25 kV Catenary	12	20
Topic 2: Overhead and Current Collecting Equipments Specific Objectives: ➢ Comprehend the importance of Overhead and Current Collecting Equipments in traction power supply, ➢ Identify Overhead Equipments in traction power supply and state its function, ➢ Describe the functions of Current Collecting Equipments in traction power supply ➢ Select current collecting equipment as per the requirements Contents: (Scope – To be restricted as per allotted time and marks) 2.1 Overhead Equipments (OHE) • Principles of Design of OHE - Composition of OHE - Height of Contact Wire - Contact Wire Gradient - Encumbrances - Span Length • Automatic Weight Tension and Temperature Compensation • Un-insulated and Insulated Overlaps, Neutral Section, Section Insulator and Isolator • Polygonal OHE - Single Catenary Construction - Compound Catenary Construction - Stitched Catenary Construction	10	20

- Modified Y Compound Catenary • Effect of Speed on OHE • OHE Supporting Structure • Different types of signal boards of OHE 2.2 Current Collecting Equipments • Systems of Supplying Power in Electric Traction - Third Rail or Conductor Rail System - Overhead System • Current Collectors for Overhead System - Trolley Collector or Pole Collector - Bow Collector - Pantograph Collector • Types of Pantographs - Diamond Pantograph - Faiveley Type • Methods of Raising and Lowering of Pantograph		
Topic 3: Signaling and Train Lighting Specific Objectives: ➢ Appreciate the importance of signaling and train lighting, ➢ State different types of signals and their meanings, and ➢ State and explain different methods of train lighting Contents: (Scope - To be restricted as per allotted time and marks) 3.1 Signaling • Requirements of Signaling System • Types of Signals • Colour Light Signals • Three and Four Aspects of Colour Light Signals. • Track Circuits. - DC Track Circuit - AC Track Circuit 3.2 Supervisory Control • Advantages of Remote Control • Systems of Remote Control - DC versus Voice Frequency (VF) Signaling - Remote Control System Equipment and Network • Mimic Diagram • Control Desk for TPC 3.3 Train Lighting • Systems of Train Lighting • Special Requirements of Train Lighting • Method of obtaining Unidirectional Polarity • Method of obtaining Constant Output • Single Battery System. • Double Battery Parallel Block System. • Failure of under frame Generating Equipments. • End on Generation.	14	20
Topic 4: Electric Locomotives Specific Objectives: ➢ Draw power circuit of Electric Locomotive and state the functions of various constituents of it, ➢ State the various Equipments in Auxiliary Circuit and their functions,	10	16

➢ List Different Type of Relays in Electric Locomotive and state their functions, ➢ List Different Type of Contactors in Electric Locomotive and state their functions, and ➢ Explain the fundamentals of three phase Locomotive Contents: (Scope – To be restricted as per allotted time and marks) 4.1 Classification of Locomotives and EMU 4.2 Power Circuit • Power Circuit Diagram of AC Locomotive • Equipments in Power Circuit and their Functions - Circuit breaker and Earthing Switch - Tap Changer - Traction Transformer - Rectifier: Rectifier Connections - Smoothing Reactor • Equipments in Auxiliary Circuit & their Functions - Head Light - Flasher Light - Horn - Marker Light - Batteries - Arno Converter - Blowers - Exhausters - Compressors - Selsyn transformer. • List and Function of Different Type of Relays • List and Purpose of Different Type of Contactors • Three Phase Locomotive - Power Circuit of Three Phase Locomotive - Power Supply Arrangement for Auxiliary - Machines in Three Phase Locomotive		
Topic 5: Protection and Maintenance of Electric Locomotive Specific Objectives: ➢ Appreciate the importance of protection and maintenance of Electric Locomotive, ➢ Explain various types of protections provided to Electric Locomotive, and ➢ Describe the maintenance policies of Electric Locomotives and state them Contents: (Scope - To be restricted as per allotted time and marks) 5.1 Protection of Electric Locomotive • Broad Strategy For Protection • Surge Protection: - Direct Lightening Strokes - Switching Surges: External and Internal • Overload Protection of Main Power Circuit • Earth Fault Protection of Power and Auxiliary Circuit • Protection from Over Voltage and Under Voltage • Differential Current Protection of Traction Circuits. • Protection against High and Low Air Pressure in the Air Circuit	10	14

• Temperature Monitoring 5.2 Maintenance of Locomotive • Need of Maintenance and Policy of Obsolescence • Defects • Ideal Maintenance • Means to Improve the Reliability of Locomotive • Means to Improve Availability of Locomotive • Means to Reduce Maintenance Cost • Maintenance Record. • Characteristics of Efficient Maintenance • Electrical Faults and Their Causes.		
Topic 6: Modern Trends in Electric Traction Specific Objectives: ➢ State new Developments in the Area of Electric Traction, ➢ Explain the working of Linear Electric Motor (LEM) Traction System, and ➢ State the Levitation Schemes used in Wheel less Traction System Contents: (Scope – To be restricted as per allotted time and marks) 6.1 LEM Propelled Traction • Linear Electric Motor (LEM) • Linear Induction Based Traction System - Moving Primary Fixed Secondary Single Sided LIM - Moving Secondary Fixed Primary Single Sided LIM - Moving Primary Fixed Secondary Double Sided LIM • Strengths/Weaknesses of LIM Propelled Railway Traction - Strengths of LIM Propelled Railway Traction System - Weaknesses of LIM Propelled Railway Traction System • Practical Possibilities of LIM Propelled Transportation	08	10
Total	**64**	**100**

List of Drawing Assignments:

Five Drawing Sheets (Half Imperial Size) and Report on each Sheet

1. Traction Substation and Feeding Post Layout
2. Overhead Equipments (OHE) and Current Collecting Equipments (at least 6 equipments on 2 sheets)
3. Signaling and Train Lighting,
4. Power Circuit in Electric Locomotive and Auxiliary Circuit Equipments

Learning Resources:

1. Books:

Sr. No.	Author	Title	Publisher
1	H. Partab	Modern Electric Traction	Dhanpat Rai & Sons
2	J. Upadhyay S. N. Mahendra	Electric Traction	Allied Publishers Ltd.
3	Om Prakash Kesari	Viddut Engine Parichay (In Hindi)	S. P. Graphics, Nashik.
4	J. B. Gupta	Utilisation of Electric Energy (Including Electric Traction)	Kataria and Sons

4. Websites:

1) http://www.railway-technical.com/etracp.shtml
2) http://www.irfca.org/faq/faq-elec.html
3) http://en.wikipedia.org/wiki/Railway_electrification_system
4) http://en.wikipedia.org/wiki/Traction_substation
5) http://www.irfca.org/faq/faq-elec2.html
6) http://en.wikipedia.org/wiki/Electric_locomotive
7) http://www.irfca.org/faq/faq-loco2e.html
8) http://www.irfca.org/faq/faq-shed.html
9) http://www.irfca.org/docs/ac-auxiliaries.html
10) http://www.railway-technical.com/elec-loco-bloc.shtml

Course Name : Diploma in Electrical Engineering

Course Code : EC / EG

Semester : Seventh

Subject Title : Elements of Industrial Automation

Subject Code : 21010

Teaching and Examination Scheme

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
04	--	02	03	100	--	--	25@	125

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

A diploma engineer has to look after the day-to-day operations, control and maintenance of controllers used in various automated industrial systems to ensure trouble free working. He should be well conversant with the various technical aspects of commonly used control components and control actions in respect of their working and performance. With the above knowledge, he should also be able to implement innovative ideas of automation wherever necessary.

Programmable Logic Controllers (PLC) have revolutionized and replaced the conventional industrial automation systems. A single PLC can reliably handle number of complex control actions in real time with high precision.

Therefore, the electrical diploma engineer must have the basic knowledge of industrial control components, actions and must be well conversant with the use of PLC therein.

General Objectives:

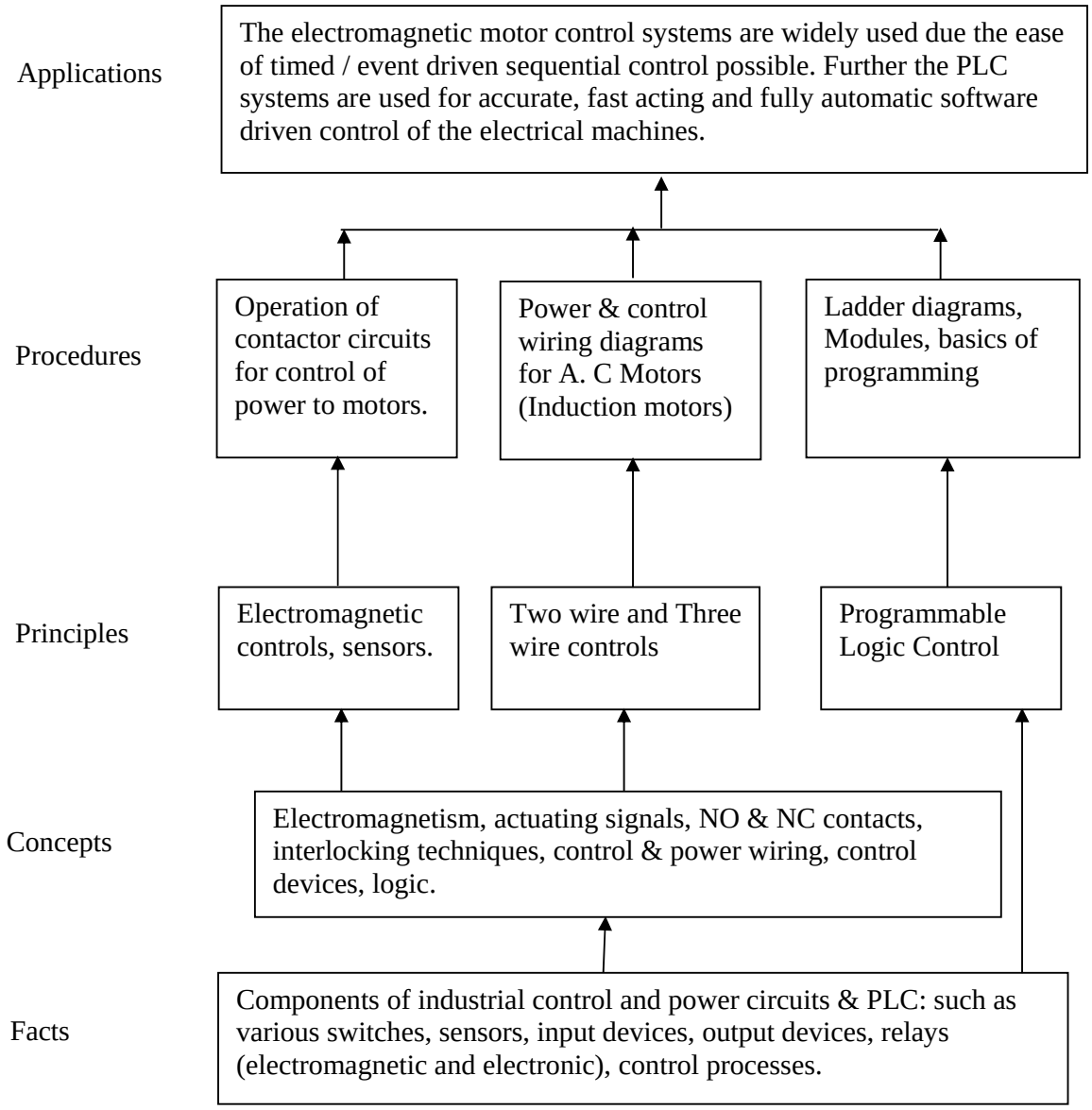
1) Understand the working of various industrial control components.

2) Use principles of machine control to design simple schemes for control.

3) Understand the working of basic control actions (viz. ON-OFF, P+I+D).

4) Know skills to use PLC for implementing simple industrial control applications.

Learning Structure:



Topics and Contents	Hours	Marks
Topic 1:Industrial Control Components Specific Objectives: ➢ Use input devices such as push button, limit switches etc. in industrial machine control ➢ Use output devices such as relays, contactors, solenoid valves etc. as actuators in industrial control ➢ Differentiate 2 wire & 3 wire controls ➢ Define & Differentiate power and control wiring Contents: 1.1 Input devices (Basic working and schematic diagrams with functions) • Definition of control devices such as Push buttons, selector switches. • Solenoid valves, Limit switches and its types • Pressure, temperature, flow, float actuated switches • Reed switches, photoelectric, hall effect, inductive, capacitive proximity switches • Two wire and three wire control. 1.2 Output devices (Basic working and schematic diagrams with function) • Concepts of NO/NC contacts • Electromagnetic Relays, contactors and their ratings, solenoid valves • Solid state Relays • Latching Relays, Bimetallic Thermal Over-load Relay, Time Delay Relays (Timers), Electronic Overload Relay • Pneumatic cylinders • Concepts of Power and control wiring diagrams, main and auxiliary contacts • Interlocking of contactor circuits using push buttons, NC contacts and limit switches. 1.3 Schematic of symbols used in industrial control circuits	12	12
Topic 2: Industrial Machine Power and Control Circuits (contactor based) Specific Objectives: ➢ Prepare power and control circuit diagrams for starters of induction motors and describe briefly the working. ➢ Prepare power and control circuit diagrams for double winding motors and describe briefly the working. ➢ Prepare plugging and braking circuits (control and power) for 3 phase induction motors and describe briefly the working. ➢ Identify applications for servo motors. Contents: 2.1 DOL starters for 3 phase induction motors • Power and control circuit diagrams of forward- stop- reverse type. • Power and control circuit diagrams of forward and random reversing type. 2.2 Star delta starters & auto transformer starters for 3 phase induction motors • Power and control circuit diagrams of semi automatic type. • Power and control circuit diagrams of automatic type using timer • Power and control circuit diagrams for motors using autotransformer type starters 2.3 Starters for slip ring induction motors	14	24

• Power and control circuit diagrams for Definite Time Limit Starter • Power and control circuit diagrams for Current Limit Acceleration Starter • Power and control circuit diagrams for Secondary Frequency Acceleration Starter 2.4 Plugging and dynamic braking of induction motors • Control and power circuits for simple plugging of motor • Dynamic Braking - D.C. injection braking power & control diagrams 2.5 Introduction to AC/DC Servo motors • Basics of construction of servo motors • Principle of working • Application areas in brief		
Topic 3. Introduction to Programmable Logic Controller Specific objectives ➢ Draw generalized block diagram of a PLC ➢ Draw simple block diagrams & state functions of different I/O modules. ➢ Know types and use of Memory in the PLC. Contents: 3.1 Introduction to PLC • Block diagram and working of Programmable Logic Controller • PLC advantages and disadvantages. • Proximity sensors /switches; inductive and capacitive types: description with simple block diagrams; areas of applications. • Opto-isolators, optical sensors. 3.2 PLC modules • digital I/O Modules and their ratings • analog I/O Modules and their ratings • timer/counter Modules • Memory: ROM: types (Mask ROM, PROM, EPROM, EEPROM) and RAM. • Functions of the above memory units. • PLC power supplies block diagram and function of each block.	12	24
Topic 4. Basic Components of PLC. Specific objectives ➢ Draw ladder diagrams for simple logic operations ➢ Use timers, counters in ladder diagrams ➢ Draw ladder diagrams for induction motor starters. Contents: 4.1 Ladder diagrams • Typical PLC inputs. • Typical PLC Outputs. • One contact, one coil circuit • Standard start-stop-seal circuit • Ladder diagrams for simple logic operations(NOT, AND, OR, EXOR) • On delay timer, off delay timer • Ladder diagrams for DOL, Star-delta (automatic) starters. • Up and down counter	14	24
Topic 5. Control Actions Specific objectives ➢ Describe in brief different control actions with their merits.	12	16

Contents: 5.1 Process control actions (block diagrams with very brief functioning descriptions) • Proportional Controllers • Integral Controllers • Proportional-Integral Controllers • Derivative Controllers • Proportional-Integral-Derivative Controllers 5.2 Brief description of the PLC working with reference to above studied control actions		
Total	**64**	**100**

Practicals:
Skills to be developed:

Intellectual Skills:

1) Understand control circuit importance.
2) Appreciate the linkage of power and control circuits.
3) Understand the characteristics of the components for motor control and power circuits.
4) To develop the Ladder diagrams as per requirements of processes.
5) To understand & appreciate the importance of analog/digital I/O Modules.

Motor Skills:

1) Connect contactors in circuits.
2) Handle the coil, contacts, reset link and other parts.
3) Handle various parts of the induction motor starters.
4) Connect components of the DOL starter, star-delta starter with the motor circuit and operate them.
5) Develop the control and power circuits of motor operation.
6) Select components for power and control sections of motor.
7) To identify application of analog/digital I/O Modules in PLC.

List of Practicals:

Sr. No.	Laboratory/drawings work
1	Draw Symbols used in electromagnetic control circuit diagrams.
2	Construction & Operation of contactors.
3	Operation of different types of switches, relays used in motor control circuits (push-buttons, limit switches, relays with at least 2 NO and 01 NC contacts)
4	Operation of Direct-On-Line (DOL) starter (connections: power and control diagrams)
5	Operation of Direct-On-Line (DOL) starter with Reversing Control (connections: power and control diagrams)
6	Semi-automatic & Fully Automatic Star-Delta Starter. (connections: power and control diagrams)
7	Operations of motor control circuit of an electric oven (if available) else trace simple

Sr. No.	Laboratory/drawings work
	power & control circuits of available equipment in workshop or elsewhere in institute.
8	Components of PLC: draw symbolic representation of at least 20 components used to create ladder diagrams.
9	Create ladder diagrams for simple process - machine systems in presence of teacher in the laboratory (any three)

Learning Resources:

1. Books:

Sr. No.	Author	Title	Publisher
1	Eshwar U. S.	Handbook of Electric Motor Controls	Tata McGraw Hill
2	Bhattacharya & Singh	Control of Electrical Machines	New Age International Publishers
3	Webb & Reis	Programmable Logic Controllers-principles and applications	Prentice Hall India
4	Biswanath Paul	Industrial electronics and control (including Programmable Logic Controller) [3rd edition only, not earlier one]	Prentice Hall India
5	Bryan & Bryan	Programmable Controllers Theory and Implementation	An Industrial Text Company Publication
6	John R. Hackworth & Frederick Hackworth (Jr)	Programmable Logic Controllers	Pearson

2. CDs, PPTs, Models, Charts etc.:

Teachers must use educational software such as that available on the internet (eg.TRiLOGI, SIEMENS etc.) for the PLC.

3. Websites:

1. www.brothersoft.com/download/plc-simulator,
2. www.edusoft.co.za/ladsim.htm