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 : SIXTH **DURATION : 16 WEEKS**

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

SR. NO	SUBJECT TITLE	abbreviation	SUB CODE	TEACHING SCHEME			EXAMINATION SCHEME									SW (17906)
							PAPER HRS.	TH (1)		PR (4)		OR (8)		TW (9)		
				TH	TU	PR		Max	Min	Max	Min	Max	Min	Max	Min	
1	Industrial Instrumentation	IIN	17984	07	01	24	03	100	40	50#	20	--	--	25@	10	50
2	Switchgear & Protection	SAP	17985	07	01	24	03	100	40	--	--	--	--	50@	20	
3	A. C. Machines	ACM	17986	07	01	24	03	100	40	50#	20	--	--	25@	10	
4	Industry Electrical Systems-II	IES	17987	07	01	--	03	100	40	--	--	--	--	--	--	
			Total	**28**	**04**	**72**	**--**	**400**	**--**	**100**	**--**	**--**	**--**	**100**	**--**	**50**

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

Total Marks **: 650**

@ - 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

COURSE CODE : EG

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

SEMESTER : SIXTH **DURATION : 16 WEEKS**

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

SR. NO	SUBJECT TITLE	abbreviation	SUB CODE	TEACHING SCHEME			EXAMINATION SCHEME								SW (17906)
							PAPER HRS.	TH (1)		PR (4)		OR (8)		TW (9)		
				TH	TU	PR		Max	Min	Max	Min	Max	Min	Max	Min	
1	Industrial Instrumentation	IIN	17984	04	--	02	03	100	40	50#	20	--	--	25@	10	50
2	Switch Gear & Protection	SAP	17985	03	--	02	03	100	40	--	--	--	--	50@	20	
3	A. C. Machines	ACM	17986	03	--	02	03	100	40	50#	20	--	--	25@	10	
4	Industry Electrical Systems-II	IES	17987	04	--	--	03	100	40	--	--	--	--	--	--	
			Total	**14**	**--**	**06**	**--**	**400**	**--**	**100**	**--**	**--**	**--**	**100**	**--**	**50**

Student Contact Hours Per Week: **20 Hrs.**

THEORY AND PRACTICAL PERIODS OF 60 MINUTES EACH.

Total Marks **: 650**

@ - 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 : EC / EG

Semester : Sixth

Subject Title : Industrial Instrumentation

Subject Code : 17984

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
04	--	02	03	100	50#	--	25@	175

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:

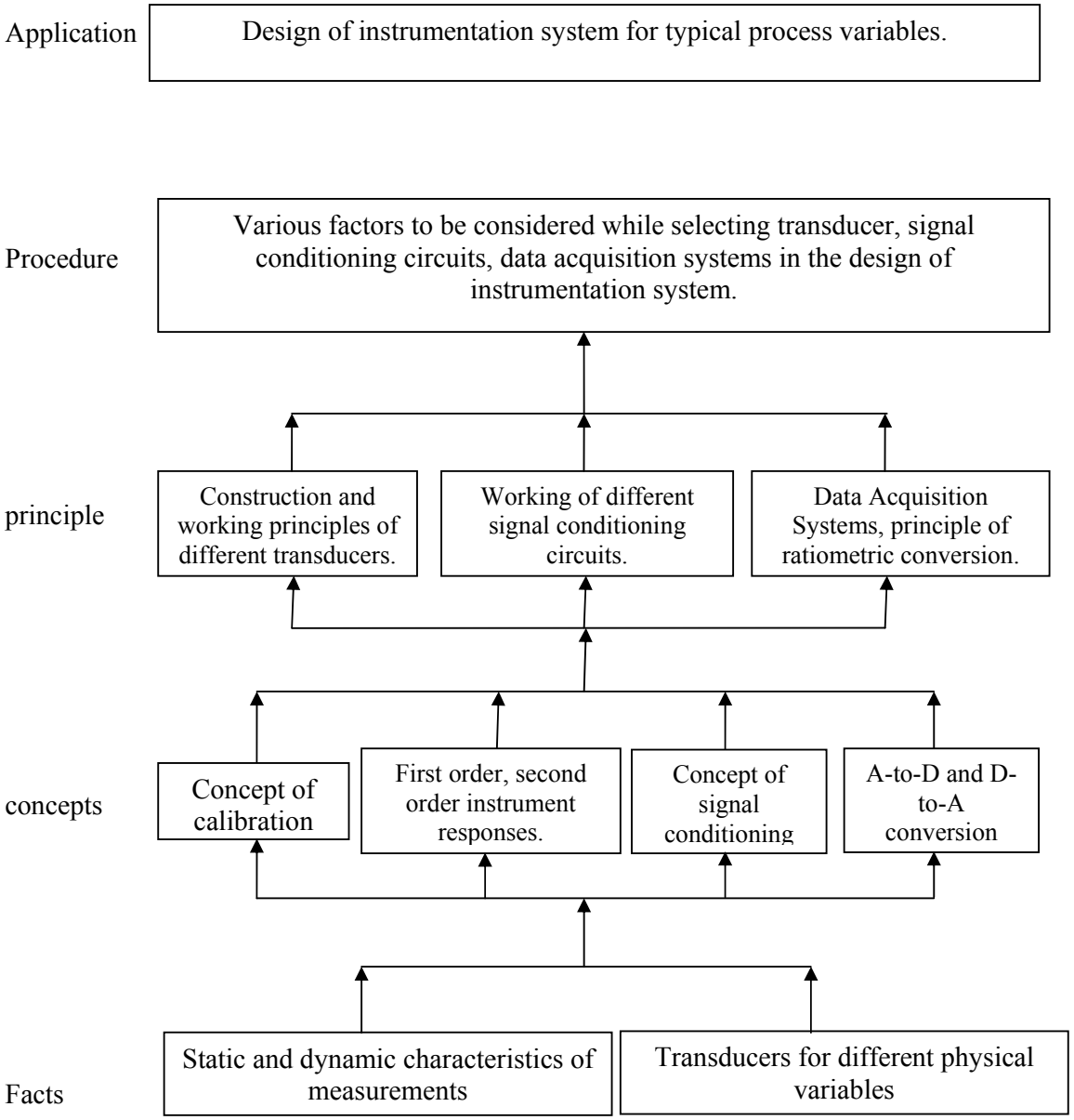
A diploma engineer is required to work in various capacities such as development, innovation & maintenance engineer, in today's highly automated industrial environment. Therefore the basic knowledge of industrial instrumentation and control is a necessary prerequisite.

He should be conversant with the basic principles of transduction of physical variables into electrical signals, signal conditioning circuits, basic data acquisitions systems.

General Objectives:

1. Identify different components of instrumentation system.
2. Understand different qualitative parameters of instruments.
3. Identify appropriate transducers for different physical variables.
4. Understand different signal conditioning circuits.
5. Understand different Data Acquisition System types and their use.
6. Design of complete system for measurement of process variables.

Learning Structure:



Theory:

Topic and Detailed Content	Hours	Marks
Topic 1: Introduction to Instrumentation System Specific Objectives: ➢ State basic block diagram of instrumentation system. ➢ Identify static and dynamic characteristics of instruments Contents: 1.1 Basic instrumentation system • Basic block diagram of generalized Instrumentation system • Need of each block. 1.2 Static characteristics of instruments • Accuracy and measurement uncertainty • Precision, repeatability and reproducibility • Tolerance • Range and span • Linearity • Sensitivity, resolution • Zero drift ,sensitivity drift • Hysteresis effect • Dead zone 1.3 Dynamic characteristics of instruments • Characteristic equation of an instrument in general form • Zero order, first order and second order representation of instruments • Response of first, second order instruments to step, ramp and sinusoidal inputs • Dynamic error, settling time 1.4 Calibration • Principles of calibration • Calibration chain and traceability	08	16
Topics 2: Transducers Specific Objectives: ➢ Classify the transducers on the basis their application ➢ Select appropriate transducer as per application ➢ Contents: 2.1: Transducers • Transducers: Definition, classification of electrical transducers. 2.2: Measurement of strain • Definition of stress and strain • Operation of resistance strain gauge • Construction of bonded metal foil strain gauge • Strain gauge circuits: Wheatstone bridge full bridge configuration, temperature compensation 2.3 Measurement of Force and Torque • Force measurement using load cell • Types of load cells: column type and beam type 2.4 Measurement of torque using torque cell 2.5 Temperature Measurement • Thermistor-working principle, characteristics, sources of error	20	32

• Thermocouple- Seebeck effect, Cold Junction compensation (CJC), CJC by electronic means, thermocouple types and their ranges. • Resistance thermometer (RTD): working principle, characteristics ranges of common RTD elements, self heating effect, advantages of platinum resistance thermometer, three wire and four wire configurations. 2.6 Displacement measurement • Linear variable differential transformer (LVDT)- working principle, characteristics, null voltage phase sensitive demodulation. • Rotary motion measurement using optical rotary encoder 2.7 Pressure measurement • Definition of pressure and its units • Absolute, differential and gauge pressure • Absolute pressure measurement using bourdon tube gauge • Diaphragm type pressure transducer using four element strain gauge rosettes. 2.8 Flow measurement • Difference between mass flow rate and volumetric flow rate • Volumetric flow rate measurement using electromagnetic flow meter, turbine type flow meter and hot wire anemometer 2.9 Measurement of magnetic field • Hall effect and hall effect transducer • Measurement of ac current by hall effect transducer 2.10 Level measurement • Float type, capacitive and ultrasonic level measurement. 2.11 Rotational velocity • Optical sensing, inductive and magnetic type pulse pickups • Analog tachometers (DC and AC)		
3. Signal Conditioning Circuits Specific Objectives: ➢ Draw basic block diagram of OP-AMP ➢ Identify different applications of OP-AMP in signal conditioning circuits. Contents: 3.1. Operational Amplifier and its characteristic parameters • Block diagram and features of OPAMP (all stages) Circuit Symbols and Terminals. OPAMP IC's: 741 pin diagram and pin function. • Ideal op-amp: electrical characteristics. Ideal voltage transfer curve. • Definitions of parameters of op-amp: Input offset voltage, Input offset current, Input bias current, Differential input resistance, Input capacitance, CMMR, SVRR, large signal voltage gain, output voltage swing, output resistance, slew rate, gain bandwidth product, output short circuit current. 3.2 OP-AMP basic circuits • Open loop and closed loop configuration of op-amp, its comparison. Virtual ground concept • Open loop configuration • Close loop configuration: Inverting, non- inverting, differential amplifier, unity gain amplifier (voltage follower),inverter(sign changer), Adders, Subtractor, Integrator, Differentiator • Instrumentation amplifier (using one two and three op-amps)	12	16

• Voltage to current converter (with floating load, with grounded load), Current to voltage converter. • Sample and hold circuit (IC LF 398 , Pin diagram, specification and pin functions) • Concept of comparator: zero crossing detector, Schmitt trigger, window detector, • Phase detector, active peak detector, peak to peak detector • Classification of filters, Concept of passive & active filters • Survey of commercially available op-amps (Any Three)		
Topic 4. Data Acquisition System Specific Objectives: ➢ Draw generalized block diagram of data acquisition system (DAS) ➢ State different types of DAS ➢ State various techniques of input signal conditioning in DAS ➢ State working principle of analog-to-digital and digital-to-analog conversion. Contents: 4.1 Generalized Data acquisition system • Generalized Data acquisition system: Block diagram. & explanation. ➢ Signal conditioning in DAS, Ratio metric conversion, Logarithmic conversion ➢ DAS Types-Single channel, multi-channel DAS only block diagram. 4.2 Analog-to-digital and digital-to-analog conversion • Study of different techniques of Analog to Digital convertors ADC and Digital to Analog converters DAC only working principle.	08	12
Topic 5. Operation of Instrumentation System Specific Objectives ➢ State different factors to be considered in transducer selection ➢ Draw block diagrams and circuit diagrams for instrumentation system for different physical variables. Contents: 5.1 Transducer selection • Points to be considered while selecting a transducer for its intended applications. 5.2 Working of Instrumentation system for • Temperature Measurement by RTD, thermistor, Thermocouple. • Force measurement using load cell. • Pressure measurement using diaphragm type transuder. • Speed measurement by non-contact type transducer • Displacement measurement by LVDT. • Rotary motion using optical encoder. • Flow measurement by turbine flow meter. • Liquid level measurement by resistive sensor. • AC current RMS indication using Hall Effect transducer.	16	24
Total	**64**	**100**

Practical:
Skills to be developed:

Intellectual Skills:
1) Selection of transducer for given physical variable.
2) Analysis of the transducer characteristics.
3) Selection of signal conditioning circuit.

Motor Skills:
Testing and calibration of the given instrument.

List of Practicals:
1. Measure output voltage and Displacement in LVDT and draw a graph to verify the characteristics of Output Voltages Vs Displacement
2. Measure output Voltage and Force in Strain Guage nd draw graph to verify the characteristics of Force Vs Output Volatage
3. Verify the relation between the output voltage and temperature by using a RTD (PT 100) thermistor and Thermocouple
4. Use a Level measuring transducer to measure level and output voltage & verify the characteristics of the transducer.
5. Plot the graph and verify the characteristics of LDR/Photo diode and photo transistor
6. Pressure measurement using diaphragm type Pressure gauge
7. Verify the function of OPAMP as inverting/non inverting amplifier, adder, subtractor.
8. Verify the function of OPAMP as comparator, Schmitt trigger
9. Plot characteristics of primary and secondary current for a current transformer.
10. Measure angular velocity using optical tachometer.

Learning Resources:
1. Books:

Sr. No.	Author	Title	Publisher
1	Alok Barua	Fundamentals of Industrial Instrumentation	Wiley India
2	H.S.Kalsi Tata	Electronic Instrumentation	McGraw Hill
3	William Dunn	Fundamentals of Industrial Instrumentation and process control	McGraw-Hill
4	A.K.Sawhney	Electrical and Electronics Measurement and Instrumentation (19^{th} Edition)	Dhanpat Rai & co
5	Cooper Helfrick	Modern electronic instrumentation and measurement techniques	Prentice Hall
6	Ramakant Gaikwad	Op-AMPs and linear integrated circuits (4^{th} Edition)	Prentice –Hall India

2. IS, BIS and International Codes:

ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories.

3. Websites:
1. Free video lectures by Prof. Alok Barua, IIT Kharagpur
2. http://freevideolectures.com/Course/2347/Industrial-Instrumentation

Course Name : Diploma in Electrical Engineering

Course Code : EC / EG

Semester : Sixth

Subject Title : Switchgear and Protection

Subject Code : 17985

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	02	03	100	--	--	50@	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:

Inspite of all care and precautions taken in the design, installation and operation of Power system and power equipments, abnormal conditions and faults do occur in the system. Some fault such as short circuits can prove highly damaging, not only to the components but also to the entire power system. However continuity of power supply is the need of the hour.

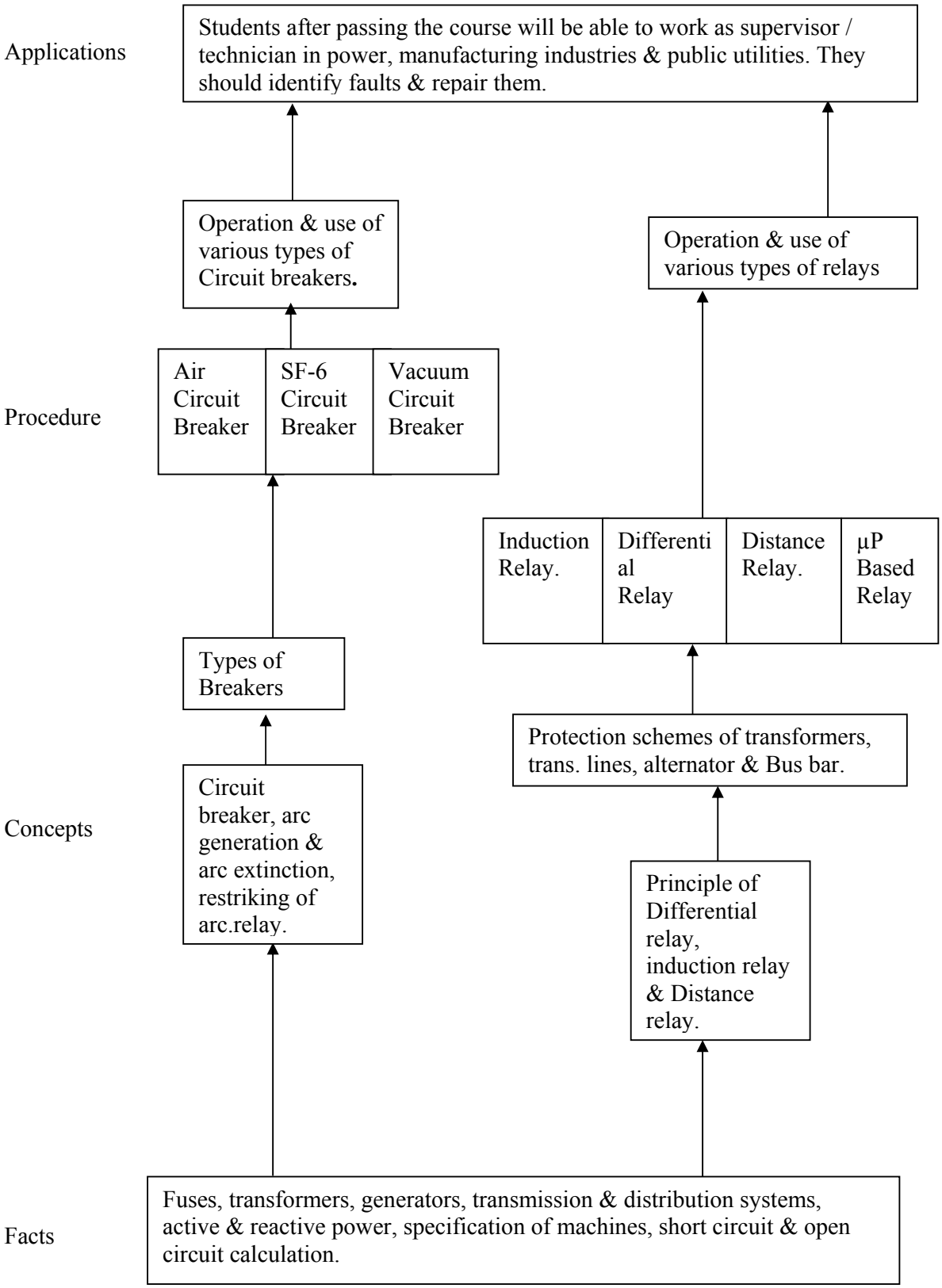
So study of switchgear and protection is needed. It is expected that the knowledge of facts, concepts, principles and procedural aspects of switchgear and protection system must be known by students which ultimately help them to maintain the reliability of electric supply in discharging their duties as a supervisor or a technician in substation, manufacturing industries and public service utilities.

General Objectives:

The students will be able to

1. Understand the principles, concepts & procedural aspects of switchgear & protection.
2. Identify various components of switchgear & protection system & their locations.
3. Know the specification and to select a switchgear for a particular application.
4. Identify various faults in power system & measures to minimize it.
5. Know the basic concepts of protection scheme and to select appropriate protection scheme for a particular application.
6. Know the need of insulation co-ordination.

Learning Structure:



Theory:

Topic and Contents	Hours	Marks
Topic 1: Fundamental **Specific Objectives:** ➢ State the need and function of protection system ➢ Differentiate the normal & abnormal conditions of power system ➢ List the types of fault & their causes ➢ Calculate short circuit current , short circuit kVA **Contents:** • Switchgear equipments - Symbols and functions • Functions of protective system. • Normal & abnormal conditions. • Types of faults & their causes. • Short circuit calculations(Symmetrical faults only) • Use of current limiting reactors & their arrangements.	04	10
Topic 2: Circuit Interrupting Devices **Specific Objectives:** ➢ List various methods of arc extinction ➢ Select circuit breaker as per application **Contents:** • Construction, characteristics of HRC Fuse • Isolators- Vertical break, Horizontal break & Pantograph type • Arc formation process, methods of arc extinction - High resistance method, Low resistance or current zero method • Definition: Arc voltage, Recovery voltage, Restriking voltage, RRRV ➢ Circuit breakers- Concept, Classification, Working principle, Construction, Specification & Applications of: • L.T.- Air circuit breakers (ACB), Miniature circuit breakers (M C B), Moulded case circuit breaker (M C C B), Earth leakage circuit breaker (ELCB), (More focus on LT C.B) • H.T – Air Blast Circuit Breaker, Sulpher Hexa Fluoride circuit breaker (SF_6), Vacuum circuit breaker**.** • Comparison of fuse & MCCB • Selection of MCCB for motor. • Selection and rating of circuit breakers	08	16
Topic 3 : Protective Relaying **Specific Objectives:** ➢ List the essential qualities of protective relaying ➢ Classify various types relays ➢ Selection of protective relays as per the system requirement **Contents:** • Quality requirements of relay system: selectivity, speed, sensitivity, reliability, simplicity, Economy: meaning of the term and its significance in protective relaying • Basic Relay Terminology - Protective relay, relay time, pick up current, reset current, current setting, plug setting multiplier (PSM) ,Time setting multiplier (TMS) • Numericals on PSM &TMS • Classification Electromagnetic relay –	09	20

• Operation of Attracted armature type, Solenoid type and Balanced beam type relays. • Electro magnetic induction type - Operation of Shaded pole type and Watt hour meter type relays. • Block diagram, Operation, Advantages & disadvantages of Static and µP based relays. • CT and PT as Protective transformers. -Safety precautions while using C.T. and P.T. , Circuit Diagram with Relay • Over current relay-Time current characteristics. • Operation of Static over current relay with block diagram • Operation of µP based over current relay with block diagram • Distance relaying- Principle, Operation of – Definite distance relay, Time distance relay and MHO relay • Directional relay- The need of directional relay, construction, operation of Induction type directional over current relay • Differential Relay- Operation of Current differential relay & Voltage differential relay.		
Topic 4 : Protection of Alternator **Specific Objectives:** ➢ State various faults and Abnormalities of alternator ➢ Sketch various protection schemes of alternator ➢ State the concept of reverse power protection ➢ Calculate the % protection provided **Contents:** • Abnormalities & Faults • Circuit diagram with proper current direction of Differential protection, Over current, earth fault, inter -turn fault, negative phase sequence, over heating protection. • Reverse power protections. (Simple numerical on differential protection)	06	12
Topic 5 : Protection of transformer **Specific Objectives:** ➢ Identify various faults & abnormalities of transformer ➢ State and draw various protection scheme of transformer ➢ Importance of Buchholz Relay ➢ Contents :- • Abnormalities & faults. • Differential, Biased differential protection • Limitations of differential protection of transformer, • Over current, Earth fault, Inter turn, Restricted earth fault, Over heating protection. • Buchholz relay (Simple numerical on differential protection)	08	14
Topic 6 : Protection of Motor **Specific Objectives:** ➢ State various faults & abnormalities of motor ➢ Observe the behavior of single phasing preventer ➢ Identify various protection provided for motors **Contents:** • Abnormalities & faults. • Short circuit protection, Overload protection, Single phase preventer- (circuit diagram, operation)	03	06

Topic 7 : Protection of Busbar & Transmission line **Specific Objectives:** ➢ Identify the faults & abnormalities of Transmission lines ➢ State the principle of over current protection, distance protection **Contents :** • Abnormalities & faults. • Bus Bar Protection – Operation of Differential Protection and Fault bus protection schemes. • Transmission line, over current, distance protection. Pilot wire protection.	04	10
Topic 8 : Neutral Earthing **Specific Objectives:** ➢ State the need of Neutral earthing ➢ Distinguish between equipment earthing and neutral earthing ➢ List types of neutral earthing Contents:- • Introduction & importance. • Types of earthing: diagram, procedure • Substation earthing: diagram, procedure • Difference between Equipment earthing and Neutral earthing	02	04
Topic 9 : Over Voltage Protection **Specific Objectives:** ➢ State the causes of over voltage ➢ List types of lightning arrester ➢ State the necessity of insulation co-ordination ➢ Identify basic components of lightning arrester Contents : • Causes of over voltages. • Lightning phenomena, over voltage due to lightning, typical waveform of lightning surge • Protection of transmission line & substation from direct stroke. • Types of lightning arresters - Rod gap, Horn gap, Expulsion and Thyrite type, their construction & principle of operation. • Surge absorber - Definition & working with neat diagram. • Protection against traveling waves. • Necessity of Insulation co-ordination,	04	08
Total	**48**	**100**

Practical:

Skills to be developed:

Intellectual Skills:

1. Identify different types of circuit breakers.
2. Identify various faults on the system.
3. Calculate the fault levels.

Motor Skills:

1. Simulate circuit configuration to create various faults.
2. Set the relays for various fault levels.

List of Practicals:

1. Survey of different switchgear equipment used in electrical power system and study of their technical specifications. (Market survey/ web based search/ visit)
2. Demonstration of working of MCB, MCCB and identification of different parts and their function.
3. Plot current (i) Vs. time (t) characteristics of a fuse (Kitkat/HRC)
4. Performance test of an electromechanical IDMT over current relay.
5. Study and understand the function and operation of microprocessor based over current relay.
6. Demonstrate operation of a protection system used for a three phase induction motor.
7. Collect data for protection system used in a typical HT substation (Transformer and Bus-bar).
8. Collect data for different types and specifications of lightening arrestor.
9. Collect data about a typical HT/LT substation earthing scheme.

Learning Resources:

1. **Books:**

Sr. No.	Author	Title	Publisher
1	S. Rao.	Switch Gear & Protection	Khanna Publications, New
2	Badriram & Vishwakarma P.N.	Power System Protection & Switchgear	TMH, New Delhi
3	V. K. Mehta	Principles of Power System	S. Chand & Co.
4	Bhaveshbhalja, R. P. Maheshwari& N. G. Chothani	Protection &Switchgear	Oxford
5	R. P. Singh	Switchgear and Power System Protection	PHI
6	Mason C.R.	The art & science of protective relaying	-----

Course Name : Diploma in Electrical Engineering

Course Code : EC / EG

Semester : Sixth

Subject Title : A. C. Machines

Subject Code : 17986

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	02	03	100	50#	--	25@	175

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.C. Machines is a core technology subject consisting constructional details, working principles, operation and characteristics of various three phase and single phase machines such as Three phase Induction motors, Three phase AC generators, three phase synchronous motor and single phase Induction motors.

AC motors are widely used in various industries such as paper industry, chemical industry, machine tools, sugar industry, agricultural applications, railway traction etc.

AC generators are used for generation of electricity in Thermal power stations, Hydro power stations, Nuclear power stations etc. The knowledge gained by the students is useful for studying technological subject such as Industry Electrical Systems, switchgear & protection, testing and maintenance of electrical equipment's and Modern electric traction.

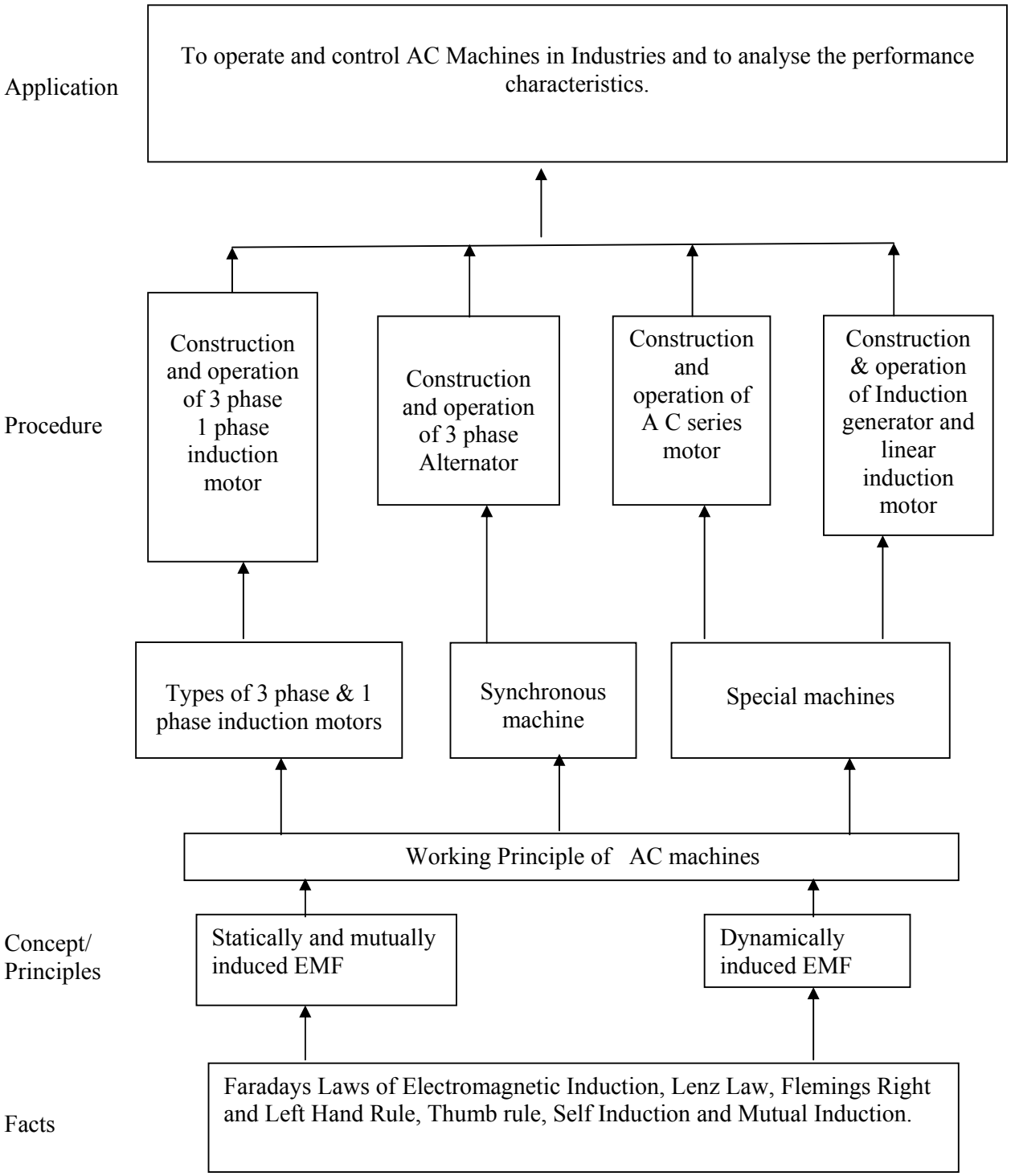
The skills acquired after studying this subject will be helpful to operate & control the machines and also to find various operating parameters of machines.

Objectives:

Students will be able to:

1. To know the various types and constructional details of AC machines.
2. To understand the working principle various AC machines.
3. To operate various AC machines.
4. To apply the knowledge for testing of machines.
5. To coordinate the knowledge for understanding the other subjects.

Learning Structure:



Theory:

Topics and Contents	Hours	Marks
Topic 1: Three Phase Induction Motor **Specific objectives:** ➢ To know the construction /working principle of three phase I.M. ➢ To find synchronous speed and slip from given data. ➢ To differentiate between standstill and running condition of three phase Induction motor. ➢ To analyze Induction motor performance by performing O.C & S.C. test ➢ To choose the particular motor for proper applications. Contents: 1.1 Constructional and operational features: 12 Marks • Types of Three phase Induction motors • Construction of three phase induction motor • Production of rotating magnetic field with vector diagram. • Working Principle. • Concept of synchronous speed and slip (Numericals) • Comparison between squirrel-cage and slip-ring induction motor. • Equation of rotor induced emf frequency, current, reactance, impedance and rotor emf under standstill and running condition • Starting and running torque equation of squirrel cage and slip ring induction motor	06	24
1.2 Characteristics : 12 Marks • Condition for maximum starting torque(Derivation) • Condition for maximum running torque (Derivation) • Torque slip characteristics of three phase induction motor • Effect of change in rotor circuit resistance on torque-slip characteristics • Effect of change in supply voltage on torque-speed • Ratio of full load torque and maximum torque (Numericals) • Ratio of stating torque and maximum torque (Numericals) • measurement of slip by • Tachometer method • Comparing rotor frequency and stator frequency • Stroboscopic method • Power stages of three phase induction motor. (Numericals)	06	
Topic 2: Starting and Controlling of Induction Motor: • Starting of 3-phase IM (No numerical) a) Direct ON Line starter b) Stator resistance starter c) Star-Delta starter d) Auto transformer starter e) Rotor resistance starter • Speed control of three phase induction motor by a) Pole changing method b) Frequency control method c) By stator voltage control d) Rotor resistance control • Applications of three phase induction motor.	04	10

Topic 3: Three Phase Alternator Specific objectives: ➢ To know the construction /working principle of three phase Alternator. ➢ To find voltage regulation of alternator. ➢ To choose the particular alternator for proper applications. Contents: 3.1 Constructional features: 16 Marks • Definition of Alternator • Construction of alternators • Working principle • Types of three phase alternators according to type of rotors • Relationship between synchronous speed and frequency • Armature winding- + Single layer and double layer. + Short pitch winding and short pitch factor. + Distribution winding and distribution factor • Derivation of e.m.f. equation of Alternator (Numericals)	06	28
3.2 Operational features: 12 Marks • Factors affecting the terminal voltage of Alternator a) Armature resistive drop b) Leakage reactance drop c) Armature reaction at various power factors • concept of Synchronous reactance and impedance • Regulation of three phase Alternator by a) Direct loading method b) Synchronous impedance method c) Amper turns method (Numericals on regulation)	08	
Topic 4: Parallel operation of Alternators: Specific objectives: ➢ To develop the skills for parallel operations and load sharing. • Need of parallel operation • Conditions for parallel operations • Synchronizing of three phase alternators a) lamp method b) Synchronoscope • Concept of Load sharing • Numericals on load sharing	04	08
Topic 5 : Single Phase Motors Specific objectives: ➢ To understand the construction /working principle of single phase Induction motors. ➢ To understand the characteristics and applications of single phase Induction motor. Contents: Constructional feature and characteristics : • Types of Single phase IM • Double field revolving theory • Study of following single phase induction motors with respect to a. Construction	06	12

b. Working principle c. Torque speed characteristics d. Applications i. Resistance start induction run ii. Capacitor start induction run iii. Capacitor start Capacitor iv. Shaded pole IM		
Topic 6: Special Machines Specific objectives: ➢ To understand the construction /working principle of single phase Induction motors. ➢ To understand the working of Induction generator. Contents: Constructional feature and characteristics : ➢ Study of following single phase induction motors with respect to a. Construction b. Working principle c. Torque speed characteristics d. Applications i. AC series motor ii. universal motor iii. Linear Induction Motor ➢ Introduction to Induction Generator ➢ Construction, Working Principle and Applications of : • D. C. and A. C. Servomotor • Stepper Motor: variable reluctance, permanent magnet and hybrid type	08	18
Total	**48**	**100**

Practicals:
Skills to be developed:
Intellectual Skills:

1. Understand the concept of working principle of Three phase induction motors.
2. Understand the concept of rotating magnetic field in Induction machines.
3. Realise the concept of slip and slip measurement.
4. Know the effect of stator voltage and frequency variations on speed of induction motor.
5. Know the starting methods of synchronous motor.

Motor Skills:

1. Ability to start and run induction motor.
2. Ability to change the direction motor.
3. Ability to feed variable frequency supply to induction motor and control its speed.
4. Ability to operate and control the machines.
5. Ability to take the precautions while operating the machines.
6. Ability to draw the characteristics and interpret the result.
7. Ability to draw the circle diagram and interpret the results.

List of Practicals:

1. A) Connect direct online starter (D.O.L) for starting three phase induction motor and reverse the direction of rotation using reversible switch
   B) Connect semiautomatic and automatic star-Delta starter for starting three phase induction motor
2. Control the speed of 3 phase induction motor by a) Rotor resistance variation b) Variable frequency supply to stator
3. Measure the slip of 3 ph induction motor using
   a. Tachometer
   b. Comparing rotor and stator frequency
   c. Stroboscope
4. Perform direct loading test on 3 ph induction motor by using
   a. Coupled Generator OR b) Brake test
5. Determine percentage voltage regulation of three phase alternator by direct loading test for different power factor
6. Determine percentage voltage regulation of three phase alternator by a) Synchronous impedance method at unity, 0.8 lagging and 0.8 leading PF b) Ampere turns method at full load for unity, 0.8 lagging and 0.8 leading PF
7. Synchronize the incoming machine (Alternator) with Bus-Bar.c8
8. Identify different windings and components of single phase, capacitor starts, Induction run motor or ceiling fan. Connect to start and reverse direction of rotation.

Learning Resources:

1.Books:

Sr. No.	Author	Title	Publisher
1	B. L. Theraja	Electrical Technology Vol-II	S. Chand & Co.
2	S. K. Bhattacharya	Electrical Machines	Tata McGraw Hill Pub Co. Ltd. New Delhi
3	K Murugesh Kumar	Electrical Machines Vol-II	Vikas publication House Pvt. Ltd.
4	K Murugesh Kumar	Induction and Synchronous Machines	Vikas publication House Pvt. Ltd.
5	M. G. Say	The performance and design of alternating current machines	CBS Publication
6	D. P. Kothari & I. P. Nagrath	Electric Machines	Tata McGraw Hill Pub Co. Ltd. New Delhi

1. IS, BIS and International Codes:

1. All motors comply with the following Indian and international standards:

IS 325	Three phase Induction motors-specification
IS:900	Code of practice for installation and maintenance of induction motors
IS 1231	Dimension of three-phase foot mounted A.C. Induction motors
IS 2223	Dimensions of flange mounted A.C. induction motors
IS:4029	Guide for testing three phase induction motors
IS:4691	Degree of protection provided by Enclosures for Rotating Electrical Machinery

IS:6362	Designation of methods of cooling for rotating electrical machines
IS 12065	Permissible limits of noise level for rotating electrical machines
IS 12075	Mechanical vibration of rotating electrical machines
IS 12615	Energy Efficient Induction motors - Three phase, squirrel cage
IEC 60045-1, 5	Rotating electrical machines - Rating and performance, degrees of protection
IEC 60072	Dimension and output ratings of rotating electrical machines

BIS: Bureau of Indian Standards
http://www.bis.org.in/

Sr. No.	Amendment to IS	Description of Amendment
01	Amendment No.3 to IS 4889:1968	Methods of Determination of Efficiency of Rotating Electrical Machines
02	Amendment No.2 to IS 14665(Pt 2/Sec 1) : 2000	Electric Traction Lifts Part 2 Code of Practice for Installation Operation and Maintenance: Section 1 Passenger and Goods Lifts
03	Amendment No.1 to IS 14578:1999	Three - Phase Induction Motors for use in Nuclear Power Plants : Specifications

Websites:

1. http://www.engineersedge.com/motors/alternators_types.htm
2. http://www.tpub.com/contents/neets/14177/css/14177_82.htm
3. http://www.learn-about-electronics.com/Three-Phase_alternator.html
4. http://www.learn-about-electronics.com/AC-current-motors.html
5. http://www.tpub.com/content/neets/12177/css/14177_65.htm
6. http://www.tpub.com/neets/book2/1c.htm
7. http://www.allaboutcircuits.com/vol_2/chpt_13/8.html
8. http://www.tecowestinghouse.com/PDF/woundrotor.pdf
9. http://en.wikipedia.org/wiki/Electric_motor#Induction_motor
10. http://en.wikipedia.org/wiki/Synchronous_motor
11. http://synchronousmotor.specaproduct.com/
12. http://www.engineersedge.com/motors/synchronous_motor.htm
13. http://www.eolss.net/Sample-Chapters/C05/E6-39A-05-03.pdf
14. http://www.allaboutcircuits.com/vol_2/chpt_13/9.html
15. http://www.allaboutcircuits.com/vol_2/chpt_13/10.html
16. http://dcacmotors.blogspot.in/2009/04/capacitor-start-single-phase-induction.html
17. http://www.newagepublishers.com/samplechapter/001136.pdf
18. http://www.wisc-online.com/objects/ViewObject.aspx?ID=IAU10908
19. http://www.hvactroubleshootingguides.com/resistance-start-induction-run-motor.html
20. http://www.hvactroubleshootingguides.com/capacitor-start-induction-run-motor.html
21. http://www.ustudy.in/node/4753
22. http://www.woodward.co.kr/storage/files/parallel%20operation%20of%20alternators.pdf
23. http://en.wikipedia.org/wiki/Electric_motor#Universal_motors
24. http://www.ustudy.in/node/6382
25. http://en.wikipedia.org/wiki/AC_motor
26. http://en.wikipedia.org/wiki/Linear_induction_motor
27. http://www.britannica.com/EBchecked/topic/182667/electric-motor/45833/Linear-induction-motors
28. http://www.msbte.com/website/curriculum/Lab Manual of 5th Semester/ACMachines.pdf

Course Name : Diploma in Electrical Engineering

Course Code : EC / EG

Semester : Sixth

Subject Title : Industry Electrical Systems-II

Subject Code : 17987

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
04	--	--	03	100	--	--	--	100

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:

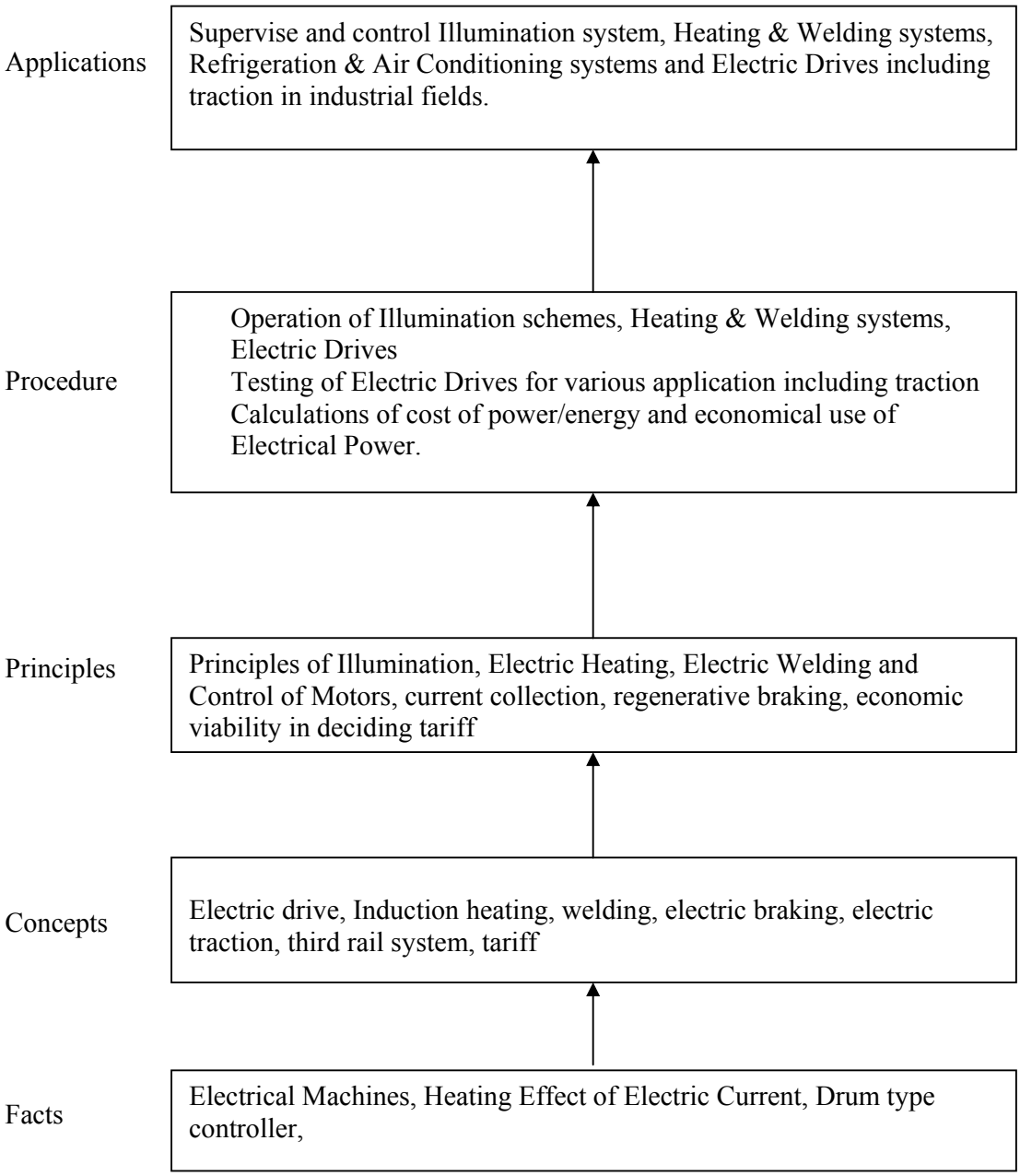
The main Job functions of a electrical diploma holder are to supervise the operation & control of various electrical drives, electrical furnaces, electrical welding equipments. The factory illumination scheme is also to be maintained by them. Therefore the knowledge of operation & control of these machines & equipments is required for every diploma engineer, Railway is the one of major employer of electrical diploma engineer; therefore it is essential for a diploma holder to acquire the knowledge of electric traction.

Due to power crises, economical utilization of electrical energy and energy conservation is an essential aspect. Hence it is essential for every diploma engineer to study the utilization of electrical energy.

General Objectives:

1. Select drive for specific application.
2. Compare different methods of electric heating & welding.
3. Explain the importance of good illumination
4. Explain the various components in electric traction system.
5. Get the knowledge of electrical energy conservation.

Learning Structure:



Theory:

Topic and Contents	Hours	Marks
Topic 1: Electric Drives & Elevators Specific Objectives: ➢ Selection of particular drive for a particular application **Contents:** • Concept of drive and its Advantages & Disadvantages • Factors Governing Selection of Electric Drives (Motor) • Nature of Drives **:-** Group, Individual & Multi motor Drives, their Advantages , Disadvantages and Applications • Mechanical Features of drives: ➢ Purpose, Types & Application of various types of Enclosure, ➢ Function of Bearing, Types of Bearing (Ball & Sleeve Bearing) Advantages & Disadvantages, Applications, • Transmission of Mechanical Power: • Direct drive and its applications • Indirect Drives: Belt, Rope, Chain, Gear& Vertical drives and their Applications, • Noise : Reasons for production of noise & Methods of Noise reduction • Size & Rating of Motor : Definition of Standard Rating as per ISS ---- a) Continuous Rating b) Continuous maximum Rating c) Short time Rating, • Load Cycles : Continuous loading, Short time loading, Long time (Intermittent) Loading, Continuous operations short time loading, Continuous operations long time loading: Concept with graphical representation • Expression of Rating of motor [No Derivation] Simple Numerical on estimating Size (Rating) of Continuously Rated Motor. • Load Equalization : Meaning of load equalization, Method of load equalization, Condition of load equalization • **Braking :** Definition of Braking, Requirements of Ideal Braking System, Advantages & Disadvantages of Electrical Braking over Mechanical Braking System. ▪ Types of electrical breaking systems: plugging, Rheostatic (Dynamic) & Regenerative braking for D.C Series Motor, 3 - Phase Induction Motor, ▪ Condition to achieve Regenerative Braking. • **Elevators:** Function, Application of Elevator, Ideal Requirements of Elevators, Meaning of Car & Pent house, Factors on which Shape & Size of Car depends, unit of Speed of Elevators, Factors affecting Speed of Elevators.	10	20
Topic 2: Electric Heating Specific Objectives: ➢ Select method of Electric Heating as per requirement of the application ➢ Decide the rating of the equipment **Contents:** • Concept of electrical heating, Classification of Electric Heating Advantages & disadvantages , Modes of Heat transfer with	10	16

definitions, • Resistance Heating:- Properties of material used as a heating element, Causes of failure of heating element, Design of heating element (Circular & Rectangular Strip), **Simple Numericals,** Methods of temperature control (By varying voltage across heating element, By varying the value of Resistance of Heating element, By use of Thermostat), • Direct & Indirect resistance heating: Meaning of the terms, Working principle, constructional features and applications • Arc Heating: - Principle of Arc Heating, Properties of material used for electrode, advantages of graphite electrode over carbon electrode,. • Direct Arc Furnace: - Constructional features and operation of arc Furnace, Specifications of arc furnace: Temperature obtain, Power Factor, Size (capacity) of furnace, Average Power required, Average Energy consumption required, and Its Applications. • Indirect Arc Furnace :- Constructional features and operation, Specifications: Temperature obtain, Power Factor, Average Power required, Average Energy consumption, Its Applications, Advantages & Disadvantages • Temperature Control : Voltage Control method & Electrode-positioning control with figure • List of Equipments used in arc furnace & their application. • Induction Heating :- Working Principle, Constructional features, Principle of operation, Advantages & Disadvantages & Applications of Direct Induction Core type furnace: Horizontal & Vertical (Ajax Wyatt)], Indirect Induction Furnace [No Numericals] • Eddy Current Heating: - Principle, Nature of Supply used, Advantages, Disadvantages & Applications. • Dielectric Heating: - Principle, Nature of supply used, Advantages, Disadvantages & Applications. [No derivation & Numericals]		
Topic 3: Electric Welding Specific Objectives: ➢ Compare Methods of Electric Welding ➢ Select type of welding for various applications/jobs **Contents:** • Meaning of the term Welding, Requirements of good welding, Advantages of electric welding, Classifications of welding system, meaning of term plastic & Fusion welding. • Factors Considered while selecting welding System for a particular job, ways and means of avoiding weld defects. • Resistance Welding: types of Resistance welding, principle and operation, applications of each type, advantages & disadvantages, Safety Equipments • Arc Welding: Principle and operation of Metal & Carbon Arc welding, Characteristics of arc, Factors on which arc length depends, methods of stabilization of arc. Types of Electrodes, advantages of coated electrode. Supply requirements, D. C. Straight Polarity and D. C. Reverse Polarity. Use of DCSP for Carbon arc welding. Advantages and Disadvantages and applications.	08	14

Topic 4: Illumination Specific Objectives: ➢ Understand the terms used in illumination System ➢ Describe various lighting schemes with their features **Contents:** • Definition of Light , Luminous flux, Intensity, Lumen, Candle Power, Illumination, Lux or meter Candle, MHCP, MSCP, MHSCP, Reduction factor, lamp efficiency, Specific Consumption, Glare, Space-Height ratio, Utilization Factor, Maintenance Factor , Depreciation Factor, Waste light Factor, Absorption Factor & Reflection Factor, Solid Angle. • Working principle, Construction, Operation and applications of: Fluorescent Tube, CFL, Mercury Vapour, Sodium Vapour and Metal Halide lamps • Types of Lighting Schemes: - direct, Semi-Direct, Indirect & semi-Indirect lighting Schemes with Applications.	06	08
Topic 5: Electric Traction Specific Objectives: ➢ Select Electric Supply Systems for Electric Traction ➢ Decide track electrification system as per requirements **Contents:** • Requirements of an Ideal Traction System. • Different types of Traction System used in India, Advantages & Disadvantages of Electric Traction System. Comparison between various Traction systems. • Systems of Track Electrification: D.C Track Electrification, Single phase 25 KV AC Supply System, Composite System: 1-Phase AC-DC Supply System. Advantages, Disadvantages and Application of above track Electrification System. Comparison between 1-phase 25 KV AC and D.C Track Electrification. • Traction Motors: Desirable Characteristics of an Ideal Traction Motor. • Various types of Traction Motors: Main Features and applications, Advantages and Disadvantages of D.C Series Motor and 1-Phase A.C Series Motor • Traction Motor Control: Steps involved in Series-Parallel Control with Rheostat and their Advantages and Disadvantages • Meaning of the term Transition, Purpose of transition, Steps involved in Shunt Transition & Bridge Transition with advantages and Disadvantages • Traction Mechanics :- Block Diagram of A.C Electric locomotive and function of each part, Classification of Traction Services: Urban, Suburban & Main line Services and their comparison • Speed time Curve: Trapezoidal and Quadrilateral Speed Time curve. Applications. • Definition of average and schedule Speed, Factors affecting Schedule Speed. (Simple Numerical).	16	24

Topic 6: Tariff Specific Objectives: ➢ Identify type of consumer based on the demand ➢ Decide the Tariff for a consumer **Contents:** • Meaning of the term Tariff, Desirable Characteristics of Tariff System. • Types of Tariff :- Block Rate Tariff, KVA Maximum Demand Tariff (Two part Tariff) & TOD (Time Of Day Tariff), Simple Numericals	04	06
Topic 7: Power Factor Improvement Specific Objectives: Decide the economical size of the P.F. improvement device for minimum cost of energy ➢ Select method of P. F. improvement as per the requirements of consumer **Contents:** • Power Triangle, Disadvantage of low Power factor, Advantages of improved Power Factor. • Causes of Low Power Factor, Avoidance of Low power factor without using P.F. improving apparatus. • P.F. improvement using Static Capacitor: Vector Diagram & Power Triangle, Advantages & Disadvantages and Simple Numericals. • Most Economical Power factor: Derivation & Simple Numericals. • Location of P.F. improving apparatus from Consumer & Electrical Supply Company point of view.	10	12
Total	**64**	**100**

Learning Resources:

1. Books:

Sr. No.	Author	Title	Publisher
1.	H.Partab	Art & Science of Utilization of Electrical Energy	Dhanpat Rai & Sons
2.	J.B.Gupta	Utilization of Electric Power & Electric Traction	S.K.Kataria & Sons
3.	V.K.Mehta & Rohit Mehta	Principals of Power System	S.Chand
4.	H.Partab	Modern Electric Traction	Dhanpat Rai & Sons
5.	S.Sivanagaraju M.Balasubba Reedy B.Srilatha	Generation & Utilization of Electrical Energy	Pearson

2. IS, BIS and International Codes:

1. IS 1860-1980 code of Practice for Installation, Operation and Maintenance of Electric Passenger and Goods Lifts.
2. IS 3534-1976 Outline Dimensions of Electric Lifts.

3. Websites:

1. sonaversity_org
2. www.animations.physics.unsw.edu.au
3. www.khanacademy.com

Visits:-

1. Visit to Sugar Industry.
2. Visit to Steel Manufacturing Industry/ Foundry.
3. Visit to welding Workshop.
4. Visit to Locomotive Shed.

These Visits may be arranged under the Subject of Professional Practices.