

Faculty of Engineering & Technology

Study and Evaluation Scheme

Of

Diploma (Engineering)- 3Years

Diploma (Engg.)- Electrical Engineering

III Year

(Applicable w.e.f Academic Session 2013-15 till revised)



AKS UNIVERSITY, SATNA

Study and Evaluation Scheme

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Faculty of Engineering & Technology
Department of Electrical Engineering

Diploma (Electrical Engg.)

V Semester

TEACHING & EXAMINATION SCHEME

S.No.	Paper Code	Subjects	L	T	P	Credit
1.	08EE501	Electrical Estimating and Costing	3	1		4
2.	08EE502	Instrumentation And Control	3	1		4
3.	08EE503	Power Electronics	3	1		4
4.	08EE504	Switchgear Operation And Protection	3	1		4
5.	08EE505	Utilization Of Electrical Power	3	1		4
1.	08EE551	Instrumentation And Control (Lab)			2	1
2.	08EE552	Power Electronics And Its Application (Lab)			2	1
3.	08EE553	Switchgear Operation And Protection (Lab)			2	1
4.	08EE554	Utilization Of Electrical Power (Lab)			2	1
		Total				24

Faculty of Engineering & Technology
Department of Electrical Engineering

Diploma (Electrical Engg.)

VI Semester

TEACHING & EXAMINATION SCHEME

S.No	Subject Code	Subject Name	L	T	P	Credit	Total Credit
1.	08EE601	Electric Traction	4	1		5	26
2.	08EE602	Energy Conservation And Management	3	1		4	
3.	08EE603	Testing And Maintenance of Electrical Machines	4	1		5	
4.		Elective	3	1		4	
1.	08EE651	Electric Traction (Lab)			2	1	
2.	08EE652	Testing And Maintenance Of Electrical Machines (Lab)			2	1	
3.	08EE653	Industrial Project			12	6	

List of Elective Subject (Student can Choose any one Subject)

Sr. no.	Subject Code	Subject Name
1	08EE604	EXTRA HIGH VOLTAGE AC/DC
2	08EE605	MICROPROCESSOR AND CONTROL SYSTEM COMPONENT

Diploma (Engg.)
Electrical Engineering
Semester-V
ELECTRICAL ESTIMATING AND COSTING

Unit-I

Principles of estimating, purchase procedure, cost of materials, various charges like labour, stores, overhead tools, contingency etc.

Unit-II

Various types of wiring systems including P.V.C. pipe, their merits and demerits. Calculation of total load & selection of wire, preparation of estimates for a small residential building, big institution or office building. Estimate for single store yard, multistory building. Estimate for a small workshop and industrial installation, agricultural pump, domestic pump, floor mills etc. Estimation of total cost.

Unit-III

Service connections For a single storey and multistoried building, single phase and three phase service connections, various methods of service connections. Distribution of circuits for light and power load. (Guidance may be taken by the M.P. Electricity Boards estimates).

Unit-IV

Preparation of estimate and costing of 11KV or 33KV line. Selection of routes. Estimates for distribution lines- Location of poles for a given situation or locality. Providing street lights, necessary hardware, stay arrangements, underground cables, providing services lines using underground cables.

Substations :- Various types of sub-stations, pole-mounted in-door and out-door substations. Estimating quantity and cost for a substation of a given specification.

Unit-V

Estimating and costing for repair/maintenance of electrical devices/equipments. Estimates for repairing electrical equipment e.g. Rewinding, assembling and testing of polyphase induction motor. Repairing of 3 phase starters. Repairing of single phase transformers. Repairing of devices like hot plate, press, mixer fan etc.

Diploma (Engg.)
Electrical Engineering
Semester-V
INSTRUMENTATION & CONTROL

Unit-I

Measuring System Elements of a measuring system, Block diagram of system configuration, performance, standards, time lag, error, distortion and distortion meters, noise and noise factor.

Unit -II

Transducers definition and classification, mechanical devices as primary detectors, Characteristic & choice of Transducers, Electrical transducers, Advantages of electric transducers, Active and passive transducers, Classification, Resistive, inductive and capacitive transducers, Potentiometric, Metallic and semiconductor strain gauges, Gauge factor, types, material used and applications. Thermistor, RTD, Inductive, LVDT, RVDT and Capacitive transducers and their application. Thermocouples, Piezo-Electric transducers, principle, materials used, mode of operation and application. Frequency generating transducers. Hall effect transducers, Opto-electronic transducers such as photo voltaic, Photo conductive, and photo conductive cells, constructional details, characteristics and applications. Photo diodes and transistors, characteristics and applications. Digital transducers,.

Unit -III

Signal Conditioners: Purpose of signal conditioning, Classification, Input modifier, Operational amplifiers circuits used in instrumentation, D.C. amplifier, chopper amplifier. Instrumentation amplifier, characteristics, three amplifier configuration. A/D and D/A converters.

Unit -IV

Measurement of Physical Quantities: Measurement of Pressure-Types of pressure measurement devices, Force summing devices, Secondary transducers, Low pressure measurement, Pirani gauge and thermocouple gauge. Resistive, Inductive and Capacitive pressure measuring devices.

Measurement of speed: Measurement of speed by stroboscope, photoelectric and reluctance pick-up devices for speed measurement.

Measurement of Temperature-Temperature measuring devices, Resistance thermometers. Radiation and Optical Pyrometers.

Measurement of Flow-Turbine and electromagnetic flow meters, Ultrasonic flow meter,

Measurement of Humidity-Humidity, absolute and relative humidity, Resistive and Capacitive hygrometers.

Measurement of pH Value-Concept, pH scale, pH cell, pH meter. Measurement of Thermal Conductivity (gas analyzer).

Measurement of Force and Torque- Electronic weighing system,

Unit V

Telemetry: Necessity, Principle, classification, current and voltage telemetry, Position telemetry,

synchros. Frequency and pulse telemetry, Principle of frequency and pulse modulation, PAM, PPM and PCM. Idea about landline and R.F. telemetry and multiplexing. Pulse code format, Modulation techniques of digital data transmission, Digital multiplexers.

Process Control- Importance and definition of variables ,open loop & closed loop control system, Block diagram,servomechanism ON-OFF center

List of Practicals: (Any Ten)

1. Measurement of Distortion using wave distortion meter.
2. Measurement of load/weight using strain gauge and cantilever.
3. Measurement of linear displacement by LVDT and draw its characteristics.
4. Measurement of temperature by-
 (a) Thermocouple (b) Resistance Thermometer
5. Measurement of pressure using LVDT and diaphragm gauge.
6. Study and use of data conversion using ADC and DAC.
7. Measurement of pH value using pH meter.
8. Measurement of Humidity by hygrometer.
9. Study and use of synchros in position telemetry system.
10. Measurement of Vibration using piezoelectric/LVDT transducer.
11. Study and flow measurement using electromagnetic flow meter.
12. Study of time division and frequency division multiplexing.
13. Measurement of liquid level by resistive/capacitive transducer.
14. Study and measurement of temperature using optical and radiation pyrometer.
15. Study of strip chart recorder and magnetic tape recorder.

References:

1. Instrumentation By Cooper
2. Instrumentation Devices and Systems by C S Rangan, G R Sharma and V S V Mani

Textbook:

1. Electrical and Electronic Measurement and Instrumentation by A.K. Sawhney.

**Diploma (Engg.)
Electrical Engineering
Semester-V
POWER ELECTRONICS**

Unit-I

SCR - Structure, Two transistor model, characteristics, turn-on methods, factor responsible for temperature rise, circuit for over voltage, over current, voltage surge & high dv/dt, Gate production. Modes of heat transfer.

Triggering circuits - Resistance phase shift, UJT, Schmitt trigger. Turn-off types of commutation, methods of commutation. SCR rating, series and parallel connection. Thyristor family and other devices, DIAC, TRIAC, SCS, SUS, LASCR, MOSFET, IGRT, GTO, MCT.

Unit-II

Rectification- Single phase HW and FW converters. Mathematical relations of I_{dc} and I_{rms} . Applications Advantages of polyphase rectification.

Unit-III

Inverter- Series and parallel inverter, current and voltage source inverter, emergency tube light, comparison of inverters using different types of (transistor, MOSFET, IGRT) devices, block diagram of UPS (on load / off load). Applications of Inverter

Unit-IV

Converter- Block diagram of DC to DC converter. Converter duty cycle, variable and constant frequency control method, 1-quadrant 2-quadrant 4-quadrant operation of choppers, applications of choppers. Working of single phase cyclo-converter, basic concept of three phase cyclo-converter, application of cyclo-converters.

Unit-V

Speed control of Motors- Advantages of electronic speed control, 4-quadrant operation of DC motors, constant torque and constant horse power operation, speed control of separately excited DC motor, single and 3 phase controlled rectifiers, field failure protection and armature current limiter, speed control using chopper, dual converter. Speed control of induction motor using rectifier, inverter and cyclo-convector (block diagram only). Speed control of slip ring induction motor using SCRS in rotor circuit.

List of Practical:

1. Characteristics of thyristor family devices.
2. Study of single phase controlled rectifiers.
3. Study of emergency tube light
4. Study of SCR triggering circuits
5. Study of commutation circuits
6. Electronic speed control of d.c.motor
7. Electronic speed control of induction motor
8. Study of UPS

9. Study of chopper

Reference:

1. Power electronics : Circuits, devices & applications, M. H. Rashid, PHI
2. Power Electronics, P.C. Jain, TMH

Textbooks:

1. P.C. Sen, Power Electronics, TMH
2. Dr. P.S. Bhimbhra, Power Electronics, Khanna Pub.

Diploma (Engg.)
Electrical Engineering
Semester-V
SWITCHGEAR OPERATION AND CONTROL

Unit-I

Introduction to power system- Growth of power system in India, future schemes, various elements of power system. Interconnection, its necessity and advantages, planning, operation and improvement of power system. Load study, type of faults.

Representation of power system- Single line diagram, use of standard symbol.

Per unit quantity - definition and advantages, base impedance conversion of per unit values from one base values to other base values. Generalized ABCD constants, their values in terms of circuit parameters. To prove $AD-BC=1$ characteristics of ABCD constants.

Unit-II

Fault analysis - Type of faults- symmetrical and unsymmetrical. Phase sequence impedance, phase sequence networks, analysis of symmetrical faults. Analysis of L-G, L-L and L-L-G fault by symmetrical components, simple numerical problems.

Unit-III

Introduction to protection- Purpose of protective system, requirement and selection. Abnormalities in a power system and their effects. Reasons for failure. Self and non self clearing faults. Use of CT/PT in protective scheme. Definition of terms regarding CT/PT. Advantages of CT/PT. Neutral earthing, their methods and advantages.

Unit-IV

Protective relay - Type of relays- induction, electromagnetic, thermal. Primary and back up relaying. Types of back up relays, causes of failure of primary relaying. Explanation of terms used in relaying. Principle and working of different types of relays- electromagnetic and induction type. Induction type over current relay, reverse power relay, time and current settings. Differential relays., distance relays, thermal relays, inverse current characteristics.

Circuit interruption devices - Function of fuse. fusing factor, fusing characteristic. Application of isolator and circuit breakers. Circuit breaker capacities. Arc formation in C.B. and methods of arc extinction. Definition of various terms with reference to circuit interruption wave form. working principle and operation of Bulk Oil/Minimum oil/air blast/SF CB. Merits and Demerits of different types of C.B.

Unit-V

Protection against over voltages - Causes and effects of over voltage. Traveling wave. Over-voltage protection, earth wire, lightning arresters- Multiple gap type, horn gap type, line type, station type and distribution type. Surge absorber.

Protective schemes- Protection of alternator- various abnormalities, Merz price differential protection, over current and earth fault protection. Protection of transformer- various abnormalities, differential protection, Buchholz relay. Feeder and transmission line protection - time graded and over current protection, current graded system, differential protection.

Protection of Induction motors, use of thermal relays and under voltage protection

List of Practicals:

1. Study of a HVDC system.
2. Study and use of CT/PT employed for protection and determine their ratio error.
3. Study of an Induction type O/C relay and plot the inverse characteristic
4. To study the differential protection of transformer/alternator.
5. Visit to power station
6. Study of different protective elements/schemes- ground wire Lightning arrestors, fuse, circuit breaker.
7. Study of Min. Oil Circuit breaker.

References:

1. Sunil S. Rao , Switchgear and protection.
2. Badriram & Vishwakarma, Power System Protection

Textbooks:

1. IJ Nagrath and DP Kothari, "Power System Engineering" Tata McGraw-Hill.
2. CL Wadhwa, "Electric Power Systems", Wiley Eastern Limited.

Diploma (Engg.)
Electrical Engineering
Semester-V
UTILISATION OF ELECTRICAL POWER

Unit-I Electric Drives

Merits and demerits of electric drives, factors governing selection of motors, drive requirements. Group and individual drive, starting and running characteristics of various motors. Selection of starters, hand operated and contractor type starters, liquid resistor type starter. Speed control of motors, load equalization, use of fly wheel. Motor enclosures, selection of motors for particular service, size and rating of motors.

Unit-II

Advantages and disadvantages of electric heating, methods of electric heating. principle of electric heating. Resistance heating elements and alloys. Causes of failures of heating elements. Arc furnaces, principle, construction, working and uses.

Induction heating principle, construction and use of Ajax Wyatt(core type) and coreless type. L.F. and H.F. Induction Furnaces. Dielectric Heating Principles and uses.(Numerical)

Electrical welding: Definition, classification of electrical welding, principle of arc welding. Qualities of a good weld. Welding defects. Resistance welding, advantages, classification, principle and working, comparison of resistance and arc welding process A.C & D.C. arc welding

Unit-III Illumination

Electromagnetic wave spectrum, solid and plane angle, definition of electrical term in use like MSEP, MHSCP etc. sensitivity of human eye. Luminous efficiency, horizontal and vertical laws of illumination, Inverse square law & Lambert's cosine law. Definition of terms used in lighting, lighting scheme, various types of lamps their uses and fittings. Numerical problems on laws of illumination.

UNIT-IV Power factor Improvement

Causes of low power factor, Disadvantages of Low power factor, power factor improvement by using static capacitors, Location of capacitors for power factor improvement, most economical power factor.

Unit-V Electro-chemical processes and storage batteries

Electro deposition and Faraday's laws of electrolysis(numerical).various electro-chemical processes like electroplating, electro-extraction, regions

Storage batteries, classification, construction. Battery maintenance. Battery charging, circuit diagram. Application of storage batteries

List of Practicals:

1. Speed control of slip ring induction motor by variation of rotor resistance.
2. To verify the change in power factor by changing load parameters and its improvement using capacitance.
3. To draw 'V' curves of synchronous motor.
4. Study and operation of resistance oven and to control its temperature.
5. Study of dielectric / induction heating.
6. Measurement of luminous efficiency of lamps by lux meter.
7. Study and operation of various types of lamps.
8. Study of arc welding.

Diploma (Electrical Engg.)
Semester-VI
ELECTRIC TRACTION

UNIT-I

Requirements of an Ideal traction system. Traction Systems: Non-electric traction systems. Electric traction systems: Straight electric traction, its advantages and disadvantages. Diesel electric traction, its advantages and disadvantages. Systems of track electrification: DC System, composite system –single phase to three phase system and single phase AC to DC system (Kando system). Advantages and disadvantages of single phase 25 Kv AC system over DC system.

UNIT-II

Traction Mechanics: - Units used in traction mechanics. Types of services , speed time curve. Average speed and schedule speed. Factors affecting the schedule speed. Tractive effort, specific energy consumption , factors affecting specific energy consumption. Coefficient of adhesion. (Simple numerical on simplified speed time curves and specific energy consumption).

UNIT-III

Traction Motors: desirable characteristics of traction motors, special features of traction motor. Suitability of DC series motor for traction. Suitability of three phase Induction motor for traction. Traction motor Control: Traction control of DC locomotives and EMUs, series parallel control combined with rheostatic control, transition from series to parallel combination (open circuit transition, shunt transition and bridge transition), energy efficiency and limitations of series parallel cum rheostatic control, chopper control of motors in DC traction systems. Traction control system of AC locomotives: Tap changer, step less voltage control through use of thyristors.

UNIT-IV

Braking: Requirement of a braking system. Mechanical braking: vacuum braking, compressed air braking, hand brake for parking. Electric braking: Rheostatic braking and regenerative braking. (no derivation and no numerical).

UNIT-V

Application of computers in management of electric traction: introduction. Computer capability relevant to electric traction. Advantages of use of computers for management of electric traction.

Reference books:

1. J. Upadhyay S. N. Mahendra Electric Traction Allied Publishers Ltd.
2. G. C. Garg Utilisation of Electric Power & Electric Traction, Khanna Publishers.

Text books:

1. Om Prakash Kesari Vidyut Engine Parichay (In Hindi) S. P. Graphics, Nashik.
2. J. B. Gupta Utilisation of Electric Power & Electric Traction, S. K. Kataria & Sons.

List of Experiment:

1. Study of electric AC locomotives.
2. Study of relays, contactors
3. Study overload protection, earth fault protection of power.
4. Study Differential current protection of traction circuits
5. Study of computer aided locomotive designs.
6. Study of monitoring execution of trip inspection
7. Study the use of computers for management of electric traction system.

Diploma (Electrical Engg.)
Semester-VI
ENERGY CONSERVATION AND MANAGEMENT

UNIT-I

Energy Conservation: Lighting energy: methods of efficient lighting. Heating: methods of energy Saving in Furnaces, Ovens and Boilers. Cooling: methods of energy saving in ventilating systems and air conditioners, energy efficient motors, automatic star/ delta converters. Power factor improvement devices and soft starters/variable frequency drives. Amorphous core transformers cogeneration – its advantages.

UNIT-II

Tariff and Energy Conservation in Industries: Energy cost and recent MSEB tariffs, application of tariff system to reduce energy bill, energy conservation by improving load factor and power factor.

UNIT-III

Energy conservation in transmission and distribution systems: reactive power compensation, demand side management, system voltage optimization and phase current balancing, losses in transmission and distribution system and its minimization.

UNIT-IV

Energy and the environment: Environment and social concerns related to energy utilization, The green house effect, global warming and its effect, acid rains, global energy and environment management.

UNIT-V

Energy Audit: Procedure of energy audit, energy flow diagram and its importance, measurements in energy audit and various measuring instruments, questionnaires for the energy audit, equipment used for energy conservation. IE rules and regulations for energy audit, Electricity act 2003.

Reference books:

1. Giovanni Petrecca Industrial Energy Management: Principles and applications Kluwer Academic Publisher.
2. Steven R. Patrick, Dale R. Patric Stephen W. Fardo Energy conservation Guide book Fairmont Press.

Text books:

1. M.J. Steinburg and T.H. Smith Economy Loading of Power plant and Electric system John Willey and sons
2. C.L. Wadhawa Generation Distribution and Utilization of Electrical Energy New Age.

Diploma (Electrical Engg.)
Semester-VI
TESTING AND MAINTENANCE OF ELECTRICAL MACHINES

UNIT-I

Electrical Accidents and Safety Measures - Electrical accidents, Safety regulations, treatment of shock, fire extinguishers.

UNIT-II

Testing and maintenance of Relays and Circuit Breakers - Testing of Relays Factory test, commissioning test and preventive periodic maintenance test. Testing of circuit breakers, voltage test, type test, preventive maintenance of circuit breaker. Hot Line Maintenance - Meaning and advantages, special types of non- conducting materials used for tools for hot line maintenance.

UNIT-III

Installation - Types of heavy Electrical equipment, unloading accessories precautions for unloading, installation of small and large machines of both static and rotating type. Installation of pole mounted transformer.

UNIT-IV

Earthing-Reasons of earthing, earthing system, earth lead and its size, permissible earth resistance for different installations, improvement of earth resistance, double earthing, earth resistance measurement, rules for earthing.

UNIT-V

Trouble Shooting -Normal performance of equipment, trouble shooting internal and external faults, instruments and accessories for trouble shooting, trouble shooting charts.

Reference books:

1. B. V. S. Rao Operation & Maintenance of Electrical Machines Vol.-II Media Promoters & Publisher Ltd. Mumbai.
2. C.J. Hubert Preventive Maintenance Hand Books & Journals.

Text book:

1. B. L. Theraja Electrical Technology Vol I To IV S. Chand & Co., New Delhi.
2. B. V. S. Rao Operation & Maintenance Of Electrical Machines Vol –I .

List of Experiment:

1. To find out Earth Resistance of :
 - a) Domestic Building
 - b) Sub-Station
2. To perform the Insulation test by Megger on:
 - a) Induction Motor
 - b) Transformer
3. To perform the Dielectric Strength Test of Transformer Oil.
4. Testing a House/ Industrial wiring and Submitting a Test Report.
5. Trouble Shooting and Repairing of DOL and Star-Delta Starter.
6. Trouble Shooting and Repairing of different type of Domestic Equipments.
7. Servicing of 1-Phase Motor (Ceiling Fan).
8. Repairing of Water Pump, Changing the bearing, Oiling, Greasing, Water seal.
9. Repairing of Heater, Coil, Hot Plate.
10. Study of Thermostat used in Refrigerator/ Water Cooler.

Diploma (Electrical Engg.)
Semester-VI
Elective-1
EXTRA HIGH VOLTAGE AC/DC

UNIT-I

Introduction : Need of EHV transmission, comparison of EHV AC & HVDC transmission, mechanical considerations of transmission line.

UNIT-II

EHV AC Transmission Parameters of EHV lines, Voltage gradient in bundle conductors lines, conductor sizing, over-voltages due to switching, ferro resonance. Insulation coordination line insulators and clearances, Corona & its effects, power loss, audible noise and radio-interference, long distance transmission with series and shunt compensations, principle of half wave transmission, flexible ac transmission

UNIT-III

HVDC Transmission :Types of dc links, terminal equipments & their operations, HVDC control system, reactive power control, harmonics and filters, multiterminal dc (MTDC) system, ac/dc system analysis, protection of terminal equipments. HVDC transmission based on voltage source-converters.

References :

1. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering" Revised Second Edition, John Wiley.
2. K.R. Padiyar, "HVDC Power Transmission System", Second revised Edition, New Age Int. 2012
3. S. Rao, "EHV-AC and HV DC Transmission Engineering Practice", Khanna Publishers.

Diploma (Electrical Engg.)
Semester-VI
Elective-2
MICROPROCESSOR AND CONTROL SYSTEM COMPONENT

UNIT-I

CONTROL SYSTEMS IN INSTRUMENTATION: Introduction. role of control system in instrumentation. Open loop and close loop control system, block diagram of open loop control system, types of open loop control system . block diagram of close loop control system , types of close loop control system , comparison between open loop and close loop control system, servomechanism and regulators with suitable examples.

UNIT-II

BASIC CONTROL ACTION AND CONTROLLER CHARACTERISTICS: On-off type control, proportional control, derivative control, Integral control, Proportional-derivative control, Proportional integral control (PID control).

UNIT-III

CONTROL SYSTEM COMPONENTS: Importance of control components. Construction, working principle, torque-speed characteristic, merits and demerits and applications of AC/ DC Servo motor , construction, working principle of synchro, synchro as transmitter-receiver and control transformer, application in position control system , construction, working principle AC/ DC Techo generator, Application of position control and speed control with feedback through Techo-generator , classification of stepper motor, construction, working principle of stepper motor , solenoid valve, control valve , servo voltage stabilizer.

UNIT-IV

MICROPROCESSOR INTRODUCTION ARCHITECTURE: Introduction to microprocessor. Advantages and disadvantages of micro processor control over traditional control. Structure of microprocessor , generalized architecture of microprocessor, functions of each block. Lumped and distributed digital control and their block diagram. Different types of memories (ROM, RAM, PROM, EPROM,EEPROM), Functional block diagram of 8085 micro processor with pin diagram, logical block diagram of 8085 microprocessor- Registers, ALU, Decoder, Serial control action, Interrupt section, timing and control section.

UNIT-V

APPLICATIONS OF MICROPROCESSOR IN INSTRUMENTATION SYSTEM:Schematic diagram of memory chips decoder, memory interphasing. Traffic light control. SCR firing angle control. Data acquisition system

Text books:

1. Automatic Control System by S.Hasan Saeed-Katson
2. Microprocessor & its application by B.Ram
3. Control System Engineering H. M. Rai.

Reference books:

1. Microprocessor Architecture, Programming and Applications with the 8085- Ramesh aonkar
2. Control System Components B. Chatterjee

List of Experiment:

1. Control of angular displacement using Synchro.
2. Study of AC and DC servo motor.
3. Use tachogenerator for automatic speed control of D.C. motor
4. Study of basic control action and controller.
5. Various servo stabiliser for automatic voltage control and study/ trace its control circuit.
6. Study of stepper motor.
7. Use microprocessor for temperature control.
8. Use microprocessor for S.C.R. firing control .
9. Study of architecture of 8085.
10. Study of data acquisition system.