EE 501 GENERATION, SWITCHGEAR & PROTECTION

L	T	P
4	0	4

RATIONALE

In view of the complexities associated with the modern interconnected power stations, the responsibilities and the job requirements of a diploma pass out have become more complex than what they used to be earlier. He is required to work with modern electrical equipment and maintain reliability of supply.

The course is designed to understand the concepts, principles involved in the construction and working of protective switch gear system so that one can handle, install , maintain them and also take decisions at his/her level in different situations.

The teaching of this subject requires reinforcement in the form of visits to substation, power stations and well designed laboratory experiences. A practice oriented approach to the teaching of this subject is suggested.

NOTE : Weightage of each topic for external examination is given in the brackets.

DETAILED CONTENTS

1. Generation (30%)
   - 1.1 Growth and development of electrical power in country; main sources of energy; conventional and non-conventional
   - 1.2 Different types of power stations thermal, hydro, diesel and nuclear power stations. Their layout, flow diagram and brief explanation of operation, comparison of power stations on the bases of capital cost, running cost, efficiency, space, maintenance and availability of the resources.
   - 1.3 Load estimation, load curves. Demand factor, load factor, Diversity factor, Simple problems there on.
   - 1.4 Base and peak load power stations. Interconnection of power station and its advantages. Concept of regional and national grid.

2. Various Faults (10%)
   - 2.1 Types of faults, short circuit fault, simple problems for calculating short circuit currents for symmetrical fault, Concept of a fault level.

3. Switchgear System : (20%)
   - 3.1 Purpose of protective gear. Difference between switch, isolator and circuit breakers. Function of isolator and circuit breaker. Breaking capacity of circuit breaker.
   - 3.2 Circuit breakers. Types of circuit breakers, oil circuit breakers, air blast circuit breakers.
   - 3.3 Principles of Arc extinction by OCB and ACB Constructional features of OCB, ACB and their working, Rating of Circuit breakers and their maintenance schedule.

3.4 Introduction to sulphur hexafluoride (SF_6) and vacuum circuit breaker.

3.5 Miniature circuit breakers and RCCB, ACB, ELCB, MCB, VCB for distribution system and transmission (Descriptive)

4. Protection Devices (20%)

4.1 Fuses; function of fuse, Classification of fuses, HV and LV fuses, their Characteristics. Types, rewireable, cartridge, HRC types.

4.2 Earthing, purpose of earthing: System earthing, Equipment earthing, Substation earthing, system earthing as per Indian Electricity rules.

4.3 Relays :

a) Function, use in protection system. Types of relays. Introduction, Electromagnetic and thermal relays. Their construction and working.

b) Induction type overcurrent, earth leakage relays

c) Directional overcurrent, differential over-current relays, their characteristics. Time and current setting

d) Idea of static relays

5. Protection Scheme : (10%)

5.1 Protection of alternator; Merz Price Protection

5.2 Protection of transformers; Merz Price Portection. Buchholz relay protection

5.3 Protection of feeders and bus bars. Over current and earth leakage protection

6. Overvoltage Protection (5%)

6.1 Protection of system against over voltage; cuases of over voltage, function of ground wire

6.2 Lightening arrestors, Rod gap, horn gap, thyrite arrestors. Surge absorbers, Zno type arrester

7. Carrier Communication: (5%)

7.1 Principle and purpose of carrier communication over power lines

7.2 Brief description of equipments with block diagram

EE 501 – Generation, Switchgear & Protection (Practical)

Visit to power station/sub-station for the conduct of following practicals.

1. Testing of the dielectric strength of transformer oil
2. Working of different types of circuit breakers and isolators
3. Working of different types of protective relays.
4. Working of CTs and PTs
5. Earthing of different equipment
6. Working of carrier communication system.
7. Study of power transformer protection scheme
8. Working of lightening arresters.

10. Study of transformer and alternator protection
11. Power factor improvement of a single phase load using capacitor bank

Recommended Books :-
Power System by V.K. Mehta
Electrical Power by C.L. Wadhwa

EE 502 - NON –CONVENTIONAL ENERGY SOURCES

L	T	P
4	0	4

RATIONALE

NOTE : Weightage of each topic for external examination is given in the brackets.

DETAILED CONTENTS

1. **Energy Resources** **(15%)**
   Basics of energy and power, conventional energy sources, their limitation and environmental impacts. Current energy situation in our country.Various non-conventional sources of energy harnessed, capacity and excepted potential of renewable sources of energy in India.

2. **Solar Energy** **(20%)**
   Introduction, solar energy supplied, solar energy utilization techniques and expertise in conversion of solar heat into electrical energy. Solar PV, cells, merits and demerits, inter conversion of solar cells, protection of solar cells. Block diagram of photovoltaic system. Solar lantern, solar PV water pumping system, solar cooking system, solar heating system.

3. **Wind Energy** **(15%)**
   Causes of wind, potential wind area, wind turbines, part of wind turbines, power in the wind, storage, limitation in using wind energy, blocked diagram of control panel of wind energy. Off Grid wind turbine systems. Voltage regulator in wind turbines.

4. **Wave Energy** **(10%)**
   Wave energy generation, wave energy conversion devices, merit and demerits of wave energy. Future and potential of wave energy in India.

5. **Tidal Energy** **(5%)**
   Potential of Tidal power and its present status of utilization, types of tidal power generation challenges and limitation.

6. **Geothermal Energy** **(10%)**
   Geothermal power plant sites in India, present utilization capacity and expected potential, energy extraction, limitation and challenges.

7. **Biomass Energy** **(10%)**
   Types and where application, energy content in the biomass, types of conversion process, biomass based fuels, calorific value of biomass based fuels, structure and design of biogas plant. (10%)

8. **Small Hydro Power Plants** (10%)

Introduction, potential of SHP in India, present utilization and excepted potential technological aspects, environmental impacts, merits and demerits of SHP. (10%)

9. **Other Non Conventional Sources of Energy** (5%)

Fuel cells, fuel cells technology. Sources of fuel cells, uses of fuel cells, environmental impact. Ocean thermal energy conversion (OTEC). Potential and challenges, blocked diagram.

EE 502 - Non –Conventional Energy Sources (Practical)

1. Study of determination of fuel cell power output.
2. Study of fuel cell control panel.
3. Testing of individual fuel cells.
4. Adjustment of wind turbine regulation.
5. Study of voltage regulator\load diverter operation.
6. Study of performance test in wind turbine.
7. Study of Photo Voltaic array mounting panels.
8. Study of battery charging procedure through alternative source of power supply.
9. Study of renewable energy.
10. Study of grid turbine system
11. Study of advanced fuel cell operation
12. Study of solar power research
13. Study of Safety, precautions of fuel cell

(Min. 10 practicals are to be conducted)

EE503-INSTRUMENTATION

L	T	P
4	0	4

RATIONALE

This subject deals with the various instruments, their construction and working which control the various parameters and operation in any industry, Electrical supervisor employed in maintenance soft electrical equipment, machinery is required to diagnose faults, rectify them and test the total system for good performance. Thus there is a need of introducing diploma holder on the basis of instrumentation.

DETAILED CONTENTS

1. Measurments **(10%)**

Importance of measurements, basic measuring systems, advantage and limitations of each measuring systems, generalized measurements systems, signal conditions and display device.

2. Transducer **(10%)**

Theory, construction and use of various transducers (resistance, inductance, capacitance, electromagnetic, piezoelectric type) optical transducers, tachogenerators, photovoltaic cell.

3. Measurements of displacement and strain **(15%)**

Displacement measuring devices: wire wound potentiometer, LVDT, stain gauge, different strain gauges such as inductance type, resistive type wire and foil etc. gauge factor gauge material and their selection, source of error and its compensation. Use of electric strain gauge, strain gauge bridge amplifier

4. Force and torque measurements **(15%)**

Different types of force measuring devices and their principles, load measurement by using elastic transducer and electrical strain gauge. Load cells providing rings. Measurement of torque by break dynamometer, electrical strain gauge, speed measurements by different methods and devices.

5. Pressure measurements **(5%)**

Bourdon pressure gauges, electrical pressure pickups and their principles, construction application use of pressure cells.

6.Flow measurements **(5%)**

Basic principle of magnetic and ultra sonic flow meters

7. Measurements of temperatures in industry **(25%)**

importance of temperature measurements in industry, seeback effect, pelter's effect, temperature scales and conversions. Principles of working, materials of constructions, advantages and limitations of the following:

i) vapor filled thermometers, gas filled thermometers, liquid filled thermometers , mercury in glass thermometers
ii) bimetallic thermometers
iii) pressure spring thermometers
iv) thermocouples
v) resistance thermometers
vi) thermisters

vii) radiation pyrometers
viii) optical pyrometers
ix) location of sensor for measurement and speed of response of sensor
x) lead wire compensation
xi) installation of thermometers

8.Transfer functional devices **(15%)**

Principle of operation, construction detail and transfer function of electrical components like limit switches,potentiometer,synchros,auto transformer,servomotors(DC & AC) stepper motors,operational amplifiers

EE503-Instrumentation (Practical)

1. Study of strain gauge and measurements of strain in given samples.
2. Study of synchro transmitter and receiver.
3. Study of piezoelectric pressure transducer.
4. Study and calibration of LVDT.
5. Study of variable capacitive transducer.
6. Study of variable inductive transducer.
7. Study of servo motors.
8. Study of solenoid valve and motor operated value.
9. Study of optical transducers.

Recommended Books:-

Experimental Methods for Engineers by JP Holman
Industrial Instrumentation by SK Singh

EE504-INDUSTRY BASED MINOR PROJECT WORK

L	T	P
0	0	8

RATIONALE

Minor project work aims at exposing the students to industrial field practices so as to have an appreciation of size, scale and type of operations; and work culture in the industries. Also the students will be able to comprehend concepts, principles and practices taught in the class room and their application in solving field / industrial problems.

Depending upon the interests of the students, location of the organization the student may be sent to :

a) Study various operations
b) Study various types of materials being used
c) Learn about various operations/processes
d) Know about various measuring instruments and test equipment
e) Study the plant layout and material handling in an industry
f) Have knowledge about production planning and control in an industry
g) Know about various quality control techniques and safety measures adopted

For effective planning and implementation of this practical training, it is suggested that polytechnic should:

a) Identify adequate number of industrial/field organizations where students will be sent for practical training

b) Prepare a work book, which can be used by students for guiding students to perform definite task during the practical training

c) Identify teachers who would supervise the students and provide guidance during practical training.

This practical training of 3-4 weeks duration will carry 100 marks. 50 marks will be given by industrial/field supervisors and 50 marks by the teacher supervising this training. The components of evaluation will include the following :

a)	Punctuality and regularity	15%
b)	Initiative in learning new things	15%
c)	Relationship with workers	15%
d)	Industrial training report	55%

E505-(A) HIGH VOLTAGE ENGINEERING

L	T	P
5	0	0

RATIONALE

NOTE : Weightage of each topic for external examination is given in the brackets.

DETAILED CONTENTS

1. **OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS (10%)**
   Causes of over voltages and its effect on power system – lightning, switching surges and temporary over voltages protection against over voltages.
2. **ELECTRICAL BREAKDOWN IN GASES,SOLIDS AND LIQUIDS (25%)**
   Gaseous breakdown in uniform and non-uniform fields – corona discharges – vacuum breakdown-conduction and breakdown in pure and commercial liquids-breakdown mechanism in solid and composite dielectrics.
3. **GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS (20%)**
   Generation of high DC AC impulse voltages and currents, tripping and control of impulse generators.
4. **MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS (20%)**
   Measurement of high voltage as and high currents – digital techniques in high voltage measurement.
5. **HIGH VOLTAGE TESTING AND INSULATION COORDINATION (25%)**
   High voltage testing of electrical power apparatus-power frequency, Impulse voltage and DC testing – international and Indian standards – insulation coordination.

Recommended Books:-

High Voltage Engineering by

Elective –I

E505(B)-DIGITAL ELECTRONICS AND MICROPROCESSOR

L	T	P
5	0	0

RATIONALE

This subject aims to give a background of digital electroics and cmicroprocessors to tlectrical diploma holders so that theymay work efficiently in industry/field. The course contents have been designed to make the students know about the fundamental principles of digital electronics and microporcessors and gain familiarity with the available IC chips. Microprocessors find applications in manufacturing and process control industries. They are also part of the electronic switching system between source and destination in long distance telecommunications.

NOTE : Weightage of each topic for external examination is given in the brackets.

DETAILED CONTENTS

1. Introduction (10%)
   - 1.1 Number systems; Binary and Hexadecimal numbers
   - 1.2 Binary addition, subtraction, multiplication and division
   - 1.3 1's and 2's compliment method of subtraction
   - 1.4 Decimal to binary and vice versa
   - 1.5 Concept of logic gates
   - 1.6 Boolean Algebra and K map

2. Logic families (10%)
   - 2.1 Definition of SSI, MSI, SLI, VLSI
   - 2.2 Basics of DTL, TTL, MOS IIL, ECL, C-MOS

3. Codes, Conversion and Parity (20%)
   - 3.1 The 8421 and BCD code numbers, its limitations and access: 3 coded numbers
   - 3.2 Addition of 8421 BCD codes numbers, its limitations and access: 3 coded numbers
   - 3.3 Gray code, gray to binary conversion and vice-versa
   - 3.4 Conversion of 8421 to decimal and vice versa
   - 3.5 Basic concepts of parity, single and double parity and error detection

4. Latches, Flip Flops, Shift Registers and Counters (25%)
   - 4.1 Basics Concepts of latches and their type
   - 4.2 Introduction to Flip Flops, difference between latch and flip-flop
   - 4.3 Concept of shift register and their types
   - 4.4 Counters and their classification:
     - a) Binary and decade counter
     - b) Divide by N ripple counters
     - c) Preset table and programmable asynchronous counters
     - d) Down counters, up/down counter
     - e) Introduction of synchronous counters
     - f) Ring counters

7. To measure voltage gain and plot the frequency response curve of single-stage feedback amplifier when by-pass capacitor is removed.
8. To measure (a) Voltage gain, (b) input and output impedance for an emitter follower circuit.
9. To measure frequency generated in (a) Hartley (b) Colpitt and (c) Wein bridge oscillators.
10. To observe the differentiated and integrated square wave on a CRO for different values of R-C time constant.
11. i) Clipping of one portion
    ii) Clipping of both portion of sine-wave using :
        a) diode and dc source
        b) zenor diodes
    iii) Clamping a sine-wave to:
        a) negative dc voltage
        b) positive dc voltage
12. To generate square-wave using an astable multivibrator and to observe the wave form on a CRO
13. To observe inggering and working of a bistable multivibrator circuit and observe its output wave forms on a CRO.

5. Memories (10%)
   5.1 Idea of volatile and non-volatine memories
   5.2 Idea of RAM, ROM, PROM, EROM and EPROM

6. A/D and D/A converters (10%)

   General idea of A/D and D/A converters and their applications

7. Microprocessors (20%)
   7.1 Definition of 8 bit, 16 bit, 32 bit microprocessor
   7.2 Architecture of 8085, its instruction set, simple problems and programming, I/O data transfer techniques
   7.3 Description of programmable peripherals interface 8255, 8251
   7.4 Introduction to 8086 and comparison with 8085

E505(B)-Digital Electronics and Microprocessor (Practical)

1. Application of digital trainer kits in truth table verifications of various logic gates
2. Development of a half adder and full adder circuit on a bread broad
3. Devleopment of a substractor circuit on a bread board
4. Different basic applications of 8085 and 8086 in the field of electrical engineering such as temperature controllers. Speed controller, pulse generator time delay circuits etc.

NOTE : Extension lecturers may be arranged for the following :

1. FAX, TELEX
2. EBABX, PBS
3. E-mail
4. Teleprinter
5. Paging Service
6. Celluar Mobile Telephones

Elective –I

E505(C)-ELECTRIC TRACTION

L	T	P
5	0	0

RATIONALE

Modern trend in public transportatio is towards fast moving traction system. Old methods have become rendered obsolete as they are not cost efficient, and new dependable systems such as electric traction systems are catching up. Emphasis is also being laid on safety alongwith economy and efficiency. In India, a large portion of railway tracks are electrified lines during coming five year plan. The technician graduates are employed in sufficient numbers in Railways for various jobs starting from planning, execution, operationand maintenance of electric traction system.

This subject will provide background knowledge regarding various traction systems, system of power supplies, over head equipment, drives, control mechanism for motors etc.

NOTE : Weightage of each topic for external examination is given in the brackets.

DETAILED CONTENTS

1. **Introduction to Traction Systems** **(10%)**
   Introduction to different traction systems like steam, diesel, electric tractionand trolley buses; advantages of electric traction over other methods of traction systems

2. **Systems of Power Supply** **(20%)**
   Different methods of power supply systems: AC single phase, 3-phase, DC systems and composite systems; rectification of power for traction systems; Economics of supply systems; Location of supply points; Neutral sections; Interference with communication systems.

3. **Over Head Equipment** **(20%)**
   Single and compound catenary construction in Railways; position of contact wire in relation to trac under various circumstances like tunnels and curvatures; General consideration on support and insulations of trolley bus routes; selectionlisation of over head line; current collector systems; pentograph.

4. **Study of Drives** **(20%)**
   Performance of DC series motor, AC series motor and induction motors on traction systems; methos of obtaining good power factor and commutation on AC series motors; Special design features of traction motors; mechanics of train movement; typical speed time curve on sub-urban and main line services; cp-dfficient of adhesion; Train resistance.

5. **Control of Motors** **(20%)**
   Methods of starting; metadyne systems; different methods of Electric braking, plugging, Rheostatic and regenerative braking in AC and DC systems; control of speed by cutting a field turns, speed control by solid state devices for AC and DC motors; high acceleration Linear Induction Motors

6. **Rail and Return Path** **(10%)**

Limiting voltage between the earth; Application of negative booster; Distribution of current and voltage on the rail; Earth return protection of underground installation against corrosion.

Elective –I

E505(D)-POWER ELECTRONICS AND DRIVES

L	T	P
5	0	0

Rationale

Power Electronics plays a very vital role in the field of control engineering in the modern industries as these industries mostly use electronic controls which are more efficient, effective and accurate. The old magnetic and electrical control schemes have become obsolete. Knowledge of components like general purpose integrated circuits, thyristers, UJTs, power diodes, power transistors and microprocessors is a must for the person working as supervisors as they have to maintain the panels in the modern control processes. The syllabus of this subject deals with the applied power electronics needed for electrical diploma holders.

NOTE : Weightage of each topic for external examination is given in the brackets.

1. **INTRODUCTION**
   Definition and concepts, Application, Power semiconductor, switches, Gate/ base drivers. Losses Snubbers.

2. **THYRISTOR FAMILY DEVICES**
   Characteristics and ratings of different thyristor family devices, their turn on land turn off methods with their protection, series and parallel connection of SCRs and their derating controlled single phase and three phase rectifiers for different types of load viz. R, R-L, R-L-E.

3. **AC to DC CONVERSION (RECTIFIER)**
   Single-phase, half wave rectifier (Uncontrolled: R load, ER-L load, R-C load, Controlled, Free wheeling diode) Single-phase full wave rectifier (Uncontrolled: R load, R-L load, Controlled, Continuous and discontinuous current mode). Three- phase rectifier (uncontrolled, controlled)

4. **AC to DC CONVERTER (CHOPPER)**
   i) General
   ii) Buck converter
   iii) Boost converter
   iv) Buck-Boost converter
   v) Switched-mode power supply
   vi) Bridge converter
   vii) Notes on Electromagnetic compatibility (EMC) and solution.

5. **DC TO AC CONVERSION (INVERTER)**
   i) General concept
   ii) Single-phase inverter
   iii) Harmonics
   iv) Modulation
   v) Three-phase inverter

6. **Single Phase and three phase voltage source and current sore inverter**
   Single phase and three phase voltage source and current source inverter, cycloconverter, choppers, PWM techniques, Characteristics and principles of AC and DC machines.

7. **MOTOR DRIVES**
   i) Motor drive systems definitions
   ii) Review of motor principles
   iii) Mechanical Requirements of Motor Drives.

8. **DC MOTOR DRIVE**
   i) General Concept
   ii) Speed Control
   iii) SCR Drives
   iv) Switched-mode DC Drives

9. **INDUCTION MOTOR DRIVE**
   i) Why induction motor (IM)?
   ii) Disadvantages
   iii) Motivation for variable-speed AC drives
   iv) Applications
   v) The state of the art in IM drives in such that most of the DC drives will be replaced with IM in very near future.

10. **MICROPROCESSOR BASED CONTROLS FOR AC AND DC MACHINES**
    Methods of conventional controls and application of static controls and microprocessor based controls for AC and DC machines.