POWER ELECTRONICS AND DRIVES

CODE EE 301

L	T	P
2	--	2/2

RATIONALE

This course aims at imparting knowledge about specific electronics aspects, which are of practical importance for an engineer in consumer and industrial applications. Increasing use of electronic gadgets in control of electrical machines makes this course indispensable for having an insight into trouble-shooting techniques.

CONTENTS

1. Introduction:

1.1 Principle, construction ,characteristics and ratings of

- 1.1.1 SCR
- 1.1.2 DIAC
- 1.1.3 TRIAC
- 1.1.4 UJT

1.2 Series connection of SCR
1.3 Parallel connection of SCR
1.4 UJT as a relaxation oscillator
1.5 Snubber circuit
1.6 Transistor analogy of SCR
1.7 Comparison of SCR and TRIAC
1.8 Over voltage and over current protection circuit for SCR.

2. Power Control Rectification:

2.1 Phase control of SCR
2.2 Different phase controlling circuits

- 2.2.1 R
- 2.2.2 RC
- 2.2.3 UJT (Pedestal and Ramp)
- 2.2.4 Transformer circuit

2.3 Different methods of turn off of SCR
2.4 Single-phase and three-phase half wave and full wave rectifier using SCR

- 2.4.1 With resistive load
- 2.4.2 With inductive load
- 2.4.3 With flywheel diode

3. Inverter :

3.1 Basic principle of inverter
3.2 Series inverter
3.3 Parallel inverter
3.4 Single phase voltage source inverter
3.5 Three phase bridge inverter
3.6 Applications
3.7 UPS

4. Chopper:

4.1 Principle of chopper operation
4.2 Control strategies

- 4.2.1 Constant frequency system
- 4.2.2 Variable frequency system

4.3 Types of chopper circuits
- 4.3.1 First quadrant or type A chopper
- 4.3.2 Second quadrant or type B chopper
- 4.3.3 Two quadrant type A chopper (type C chopper)
- 4.3.4 Two quadrant type B chopper (type D chopper)
- 4.3.5 Four quadrant chopper (type E chopper)

5. Cycloconvertor :

5.1 Principle of cycloconvetor
- 5.1.1 Single phase to single phase circuit step up cycloconverter
  - 5.1.1.1 Mid point cycloconverter
  - 5.1.1.2 Bridge type cycloconverter
- 5.1.2 Single phase to single phase circuit step down cycloconverter
  - 5.1.2.1 Mid point cycloconverter
  - 5.1.2.2 Bridge type cycloconverter

5.2 Three phase half wave cycloconverter
- 5.2.1 Three phase to single phase cycloconverter
- 5.2.2 Three phase to Three phase cycloconverter

6. SMPS :

6.1 Types of SMPS
6.2 Protection circuits
6.3 Merits and Demerits of SMPS

7. AC Stabilizer :

7.1 Introduction
7.2 Working and basic circuits of
- 7.2.1 Resonator stabilizer
- 7.2.2 Electro-mechanical stabilizer
- 7.2.3 Electronic stabilizer

8. Speed Control of Motors:

8.1 Introduction
8.2 Speed control of motors using SCR for
- 8.2.1 D.C. shunt motor and series motor
- 8.2.2 Single phase and three phase induction motor
- 8.2.3 Slip ring induction motor
- 8.2.4 Brush less DC motor

9. Time :

9.1 Types of timer circuits
9.2 Principles and operation
9.3 Electronic timers
9.4 D.C. operated timer
9.5 A.C. operated timer

PRACTICALS

1. Draw characteristics of SCR.
2. Draw characteristics of TRAIC.
3. Draw characteristics of DIAC.
4. Draw characteristics of UJT
5. Study of UJT oscillator

6. Speed control of D.C. Shunt motor.
7. Speed control of D.C series motor.
8. Study of various SCR firing circuits.
9. Study of various commutation circuits.
10. Speed control of A.C 1-phase motor.
11. Speed control of A.C 3-phase induction motor.
12. Use of TRIAC in a dimmer circuit.
13. Study of TRIAC in rectifier mode
14. Study of single phase half wave rectifier using SCR with resistive load
15. Study of (single phase) SCR with inductive load
16. Study of (with free wheeling diode) SCR with inductive load.
17. Study of single phase full wave rectifier using SCR with resistive load.
18. Study of SCR with R-L load and free wheeling diode.

REFERENCE BOOKS :

1. Power Electronics — P.C. Sen
2. Motor Control — P.S Bhimbra
3. Thyristor Engineering — M.S. Berde
4. Industrial Electronics — G.K. Mithal
5. Thyristor Control Drive — G.K. Dubey
6. पॉवर इलेक्ट्रोनिक्स — जलान्धरा, माथुर

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UTILIZATION OF ELECTRICAL POWER AND TRACTION

CODE EE 302

L	T	P
2	1	–

RATIONALE

The knowledge of utilization of electrical power is important for an electrical engineer. This subject assumes importance in view of the fact that an engineer has to work in a wide spectrum of activities wherein he has to make selections from technical, economical and availability considerations.

The subject contents are designed to meet the above requirements and an engineer after undergoing this course shall be in a position to operate and keep the equipment used in utilization of electrical power.

CONTENTS

1. Industrial Utilization :

1.1 Advantages of electrical drives over mechanical drives
1.2 Group and individual drives
1.3 Characteristics and application of various types of electric motors
1.4 Selection of electrical motors for

1.4.1 Domestic uses - Fans, sewing machines, refrigerators, air conditioners, coolers, mixers and grinders, washing machines, hair dryer
1.4.2 Industrial uses - Lathes, drilling machine, elevators, cranes lift, conveyors, textile and paper mills.

2. Electric Heating :

2.1 Principle of electric heating
2.2 Advantages of electric heating
2.3 Methods of heating

2.3.1 Resistance heating
2.3.2 Induction heating
2.3.3 Dielectric heating

3. Electric Welding:

3.1 Principle of electric welding
3.2 Classification of electric welding
3.3 Resistance welding

3.3.1 Spot welding
3.3.2 Butt welding
3.3.3 Seam welding

3.4 Arc Welding

3.4.1 Metal arc welding
3.4.2 Carbon arc welding

3.5 Comparison between resistance and arc welding

4. Illumination:

4.1 Terms used in illumination
4.2 Laws of illumination

4.2.1 Inverse square law
4.2.2 Lambert's cosine law

4.3 Electrical sources of light
4.3.1 Design of lighting schemes for domestic, commercial and industrial premises based upon illumination level required for various works.

4.4 Types of lamps
4.5 Comparison of fluorescent tubes and filament lamps
4.6 Requirement of good lighting
4.7 Lighting schemes for flood light

5 Traction Systems:

5.1 Ideal traction system
5.2 Different systems of traction
5.3 Systems of electric traction
5.4 Systems of track electrification
5.5 Comparison between D.C. and A.C. systems of railway electrification form the point of view of main line and suburban line railway service.

6 Train Movement and Energy Consumption:

6.1 Speed time curves
6.2 Typical speed time curves
6.3 Definition of crest speed, average speed and schedule speed
6.4 Factors affecting schedule speed
6.5 Simplified quadrilaterals speed time curves
6.6 Tractive effort for propulsion of train
6.7 Determination of specific energy output using simplified speed time curves
6.8 Factors affecting energy consumption
6.9 Definition of dead weight, accelerating weight and adhesion weight

7. Electric Traction Motors:

7.1 General features of traction motor
7.2 Characteristics of Motors
7.2.1 D.C. Series motor

7.2.2 D.C. shunt motor
7.2.3 A.C. Series motor
7.3 Rating and ventilation

8 Power Supply:

8.1 System of supply of power for electric traction
8.2 Current collector for overhead systems
8.3 Overhead construction for tramways trolley buses and railway
8.4 Sag and tension calculation for a trolley wire
8.5 Transmission lines to feed substations
8.6 Location of substations
8.7 Feeding and distribution systems
8.8 Protective device

REFERENCE BOOKS :

1.	A Course in Electrical Power	J .B. Gupta
2.	Utilization of Electric Power & Electric traction	G.C. Gay
3.	Art & Science of utilization of Electrical Energy	H. Partab
4.	Electrical Utilization & Traction	Yash & Basant
5	Electric Drives	G.K. Dubbey

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ESTIMATING , COSTING & DESIGN OF ELECTRICAL INSTALLATIONS

CODE EE 303

L	T	P
2	2	2/2

RATIONALE

A diploma holder in electrical engineering is usually employed in state electricity boards, industries etc. Where they have to design, prepare estimates and prepare drawings for residential buildings, small workshop, distribution substation, grid substation, overhead and underground systems.

Practically a diploma engineer is required to estimate material requirements. But for the basic concepts some exposure to estimating and costing is also thought essential for the diploma engineer. This course shall make him aware about estimating ,costing and installation of various electrical applications. The course contents gives the knowledge to learn installation design ,estimating and costing principles

CONTENTS

1. Wiring Materials and Accessories:

1.1 Different electrical symbols
1.2 Brief description, general specification and approximate cost of

1.2.1 Different types of wire and cable
1.2.2 Switches, socket outlets, ceiling roses, lamp holders, plugs
1.2.3 Conduits and it accessories
1.2.4 Distribution boards and boxes
1.2.5 Fuses, MCB, isolators, E.L.C.B. and energy meters
1.2.6 Incandescent, Fluorescent and discharge lamps
1.2.7 D.C. and A.C. motors and starters

2. General Principle of Estimating and Costing :

2.1 Purpose and essential of estimating and costing
2.2 Preparation of list of materials
2.3 Market survey, price list and net prices
2.4 Calculation of material and labour cost, contingencies, supervision, overhead charges, profit and total cost.
2.5 Purchase process: quotations, comparative statement, purchase order, tender order, security money

3. Earthing :

3.1 Need of earthing
3.2 Pipe and plate earthing
3.3 Schedule of material and accessories, costing and estimates.

4. Service Connection:

4.1 General rules and regulation
4.2 Overhead and underground service connection
4.3 Schedule of material and accessories for single phase and three-phase service connection
4.4 Costing of material and work

5. Plan Estimation of 1-ϕ and 3-ϕ Electrical load :

5.1 Installation plan
5.2 Single line-wiring diagram
5.3 Calculation of conductor size
5.4 Design for main switch boards and distribution board
5.5 Calculation of number of circuits
5.6 List of material required for following and preparation of estimate, calculation of material cost using PWD B.S.R.
- 5.6.1 Single storey & Multi storey building
- 5.6.2 Small workshop
- 5.6.3 Agricultural pump
- 5.6.4 Institution or office building

6. Design of Distribution Lines :

6.1 Design and estimate the material required for the following with specifications -
- 6.1.1 L.T. Overhead distribution line
- 6.1.2 H.T. Overhead distribution line.

7. Sub Station :

7.1 Classification of substations

- 7.1.1 Indoor and Outdoor substation
- 7.1.2 Pole mounted substation
- 7.1.3 Platform type substation
- 7.1.4 Industrial substation

7.2 Selection of site for distribution substation
7.3 Estimation of material required for distribution substation

8 Description and Layout of Grid Substation 33/11 and 220/132 KV :

8.1 Selection of site
8.2 Equipment used in G.S.S. with specification
8.3 Single line diagram
8.4 Estimate and costing of material required
8.5 G.S.S. Earthing

9. Design of a Distribution Scheme for a Small Colony :

9.1 Load survey
9.2 Load curves
9.3 Rating of sub-station transformer
9.4 Conductor size
9.5 Arrangement of street lighting
9.6 Arrangement of conductors on poles
9.7 Plan of distribution route

PRACTICALS

1. Design and estimate the material of electrical installation for the following (by conventional method).

1.1 Residential building up to 40 points
1.2 Office building up to 30 points
1.3 Community hall up to 40 points
1.4 Small workshop up to 10 light points and 5 power points
1.5 Motor pump set

2. Preparation of schedule of material and estimate for the following using PWD B.S.R.

2.1 Residential building up to 40 points
2.2 Office building up to 30 points
2.3 Community hall up to 40 points
2.4 Small workshop up to 10 light points and 5 power points
2.5 Motor pump set

3. Design and preparation of schedule of material of estimate for service connection

3.1 1-ϕ Overhead
3.2 3-ϕ overhead
3.3 1-ϕ underground
3.4 3-ϕ underground

4. Design and estimate the list of materials for the following :

4.1 H.T. Overhead distribution main up to 20 Km.
4.2 L.T. Overhead distribution main up to 5 Km
4.3 Pole mounted substation.
4.4 Single line diagram of 220/132 KV G.S.S. and 33/11 KV substation
4.5 Three line diagram of 33/11 KV substation.
4.6 Design of distribution scheme for a small colony including load survey, load charts, load curves etc.
4.7 Idea of method used in RSEB to calculate the voltage regulation of LT line.
4.8 G.S.S. Earthing.

REFERENCE BOOKS :

1. Electrical Estimating & Costing — S.L.Uppal
2. Electrical Estimating & Costing — J.B.Gupta
3. Installation, Design & Drawing — J.B. Gupta
4. Electrical Engg. Drawing — Surjeet Singh
5 Electrical Estimating and Costing — TTTI Madras
6. Electrical Estimating and Costing — M.F. Buereslui
7. Electrical Estimating and Costing — Raina, Bhattacharya

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ELECTRICAL DESIGN AND DRAWING

CODE EE 304

L	T	P
2	1	2

RATIONALE

Design aspect for diploma engineers is not much as compared to drawing and estimating. Practically an Engineer is required to estimate material requirements. But for the basic concepts some exposure to design aspects is also thought essential for engineers. This course shall make engineers aware about design, drawing and total material requirement for various jobs.

The contents shall make an Engineer to learn design concepts, draw various circuits of power systems and estimate requirements of materials for electrical works.

CONTENTS

1. Transformer Design :

1.1 Single phase and three-phase core type distribution transformer
1.2 Single phase shell type transformer
1.3 Output equation
1.4 Main dimension of frame
1.5 Core design and winding design

2. Design of Winding :

2.1 Definition of -

2.1.1 Single and double layer winding
2.1.2 Full pitch and short pitch winding
2.1.3 Integral and fractional winding

2.2 Developed winding diagrams of single phase and three-phase induction motors
2.3 Developed winding diagrams of alternators

3. D.C. Machine Design :

3.1 Choice of specific magnetic and specific electric loading
3.2 Output equation (Armature Design)
3.3 Calculation of main dimensions
3.4 Output coefficients
3.5 Choice of number of poles
3.6 Design of shunt field winding

4. 3-Phase Induction Motor Design :

4.1 Choice of specific magnetic and specific electric loading
4.2 Output equations
4.3 Calculation of main dimensions
4.4 Relation between D and L
4.5 Effect of length of air gap on motor performance
4.6 Calculation of no load current

5. Simple Alarm and Signal Circuits :

Using contactors, designing and drawing schematic and wiring diagrams of alarm and signal circuits. Circuits should involve use of switches, push buttons, bells, indicating light which are used in offices, hospitals, hotels and buses etc.

6. Contactor Control Circuits :

6.1 The circuit should incorporate remote control, interlocking, time delay, sequential operation, overload short circuit and no-load protection applicable to -

6.1.1 D.O.L starter
6.1.2 Star-Delta starter
6.1.3 Rotor resistance and reversing starters.

6.2 Contactor control schematic and wring diagram for speed reversing of motors.
6.3 Contactor control schematic and wring diagram for fast and slow speeds of motors.
6.4 Contactor control schematic and wiring diagram of sequential operation of motors.
6.5 Control of pump motor with water level indicators.

7. Panel Wiring Diagram : Panel wiring diagram for the following with usual protective devices and showing the various equipment with suitable ranges -

7.1 Synchronization and parallel operation of 3-phase alternators
7.2 A.C. 3-phase squirrel cage induction motor.
7.3 A.C. 3-phase slip ring induction motor.
7.4 Parallel operation of three phase transformers
7.5 D.C. compound generator
7.6 Parallel operation of D.C. compound generators

PRACTICALS

Preparation of drawing sheets for the following.

1. Electrical symbols as per I.S. 1 Sheet
2. Preparation of sectional plan, elevation and view of transformer
   - 2.1 Single-phase core and shell type 1 Sheet
   - 2.2 Three-phase core and shell type 1 Sheet
3. Alarm circuits. 3 Sheets
4. Contactor circuits. 3 Sheets
5. Developed winding diagrams. 4 Sheets
6. Panel wiring diagram. 3 Sheets

REFERENCE BOOKS :

1. Electrical Design, Estimating and Costing — K.B. Raina, S.K. Bhattacharya
2. Electrical M/C Design — A.K. Shawney
3. Electrical Drawing and Design — Jaggi
4. Electrical M/C Design — V.N. Mittal
5. Electrical Engg. Drawing — Surjit singh
6. Electrical Engg. Drawing — J.B.Gupta
7. Handbook of Electrical Engg. — S.L. Bhatia

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FUNDAMENTALS OF CONTROL SYSTEM

CODE EE 305

L	T	P
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RATIONALE

This course aims at imparting the basic concept of control systems. Now a days automated industries are growing at a fast speed. A diploma holder must have knowledge of control procedure. After studying this course the students will be capable of implementation of these principles in process industries as well as engineering industries.

CONTENTS

1. Control System:

- 1.1 Basic definition
- 1.2 Open loop and Closed loop systems
- 1.3 Transfer function
- 1.4 Transfer function of different R- C networks
- 1.5 Block diagram and its reduction technique
- 1.6 Signal flow graph and Mason's gain formula

2. Control System Components :

- 2.1 D.C. Servo motor
- 2.2 A.C. Servo motor
- 2.3 Synchro pair
- 2.4 Tachogenerator

3. Time Domain Analysis :

- 3.1 Various test signals used in control system (step, impulse, ramp, parabolic)
- 3.2 Impulse response
- 3.3 First order and second order system
- 3.4 Time domain specifications
- 3.5 Step response of first order and second order system
- 3.6 Stability analysis of control system
  - 3.6.1 Absolute satiability
  - 3.6.2 Marginal satiability
  - 3.6.3 Relative satiability
  - 3.6.4 Asymptotic satiability
- 3.7 Routh's stability criterion
  - 3.7.1 Formation of Routh array
  - 3.7.2 Difficulties in formation of Routh array and their remedies
  - 3.7.3 Determination of gain K
- 3.8 Static and dynamic error coefficients

4. Frequency Response :

- 4.1 Frequency domains analysis
- 4.2 Frequency domain specifications
- 4.3 Gain margin and phase margin
- 4.4 Polar plots
- 4.5 Bode plot
- 4.6 Nyquist stability criterion
- 4.7 Stability analysis using Nyquist plot and Bode plot
- 4.8 M & N circle

5. Root Locus :

5.1 Introduction
5.2 Rules for constructing root loci
5.3 Root locus plots
5.4 Effect of Zeros and Poles on root locus

REFERENCE BOOKS :

1. Control System Engg. Nagrath & Kothari
2. Control System B.C. Kuo
3. Control System Engg. Ogata
4. Automatic Control System Hassan Saeed

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ELECTRICAL MACHINES - II

CODE EE 306

L	T	P
2	1	2

RATIONALE

An electrical engineer is supposed to handle electrical machines wherever he may work. The requirement and knowledge of electrical machines, such as AC generators, AC motors is quite large. It is expected that an engineer will install, commission, operate, maintain and if required shall test these machines.

The course contents give full knowledge to learn operating principles, performance and testing of various types of electrical machines. The expected achievement shall make an engineer fully competent to handle any problem related with electrical machines.

CONTENTS

1. Induction Motor:

1.1 Production of rotating magnetic field by two phase and three-phase supply
1.2 Construction of slip ring and squirrel cage motors
1.3 Principle of operation
1.4 Slip
1.5 Torque Production

1.5.1 Gross torque and shaft torque
1.5.2 Starting torque
1.5.3 Maximum torque
1.5.4 Full load torque
1.5.5 Relation between starting, maximum and full load torque

1.6 Torque-slip characteristics & effect of rotor resistance
1.7 Power stages and efficiency
1.8 Equivalent circuit: approximate and exact
1.9 Phasor diagram
1.10 No-load and blocked rotor tests
1.11 Circle diagram
1.12 Methods of starting
1.13 Speed control of induction motors

1.13.1 Rotor resistance control
1.13.2 Stator voltage control
1.13.3 Frequency control
1.13.4 Pole changing method
1.13.5 Cascade control

1.14 Cogging and crawling
1.15 Double cage induction motor, characteristic, applications

1.16 Industrial applications

2. Single Phase Induction Motor :

2.1 Double revolving field theory and cross-filed theory
2.2 Construction, working principle and characteristics of following motors
- 2.2.1 Resistance start
- 2.2.2 Capacitor start & induction run
- 2.2.3 Capacitor start & capacitor run
- 2.2.4 Shaded pole motor

2.3 Industrial applications

3. Alternators :

3.1 Constructional features
3.2 Principle of operation
3.3 Winding factors
3.4 EMF equation
3.5 Idea of leakage reactance (cylindrical rotor) and armature reaction
3.6 Synchronous reactance synchronous impedance
3.7 Phasor diagram at different power factors (cylindrical rotor)
3.8 Voltage regulation
3.9 Open circuit and short circuit tests
3.10 Calculation of voltage regulation by synchronous impedance and m.m.f methods
3.11 Parallel operation of three phase alternators
3.12 Effect of variation in excitation and prime mover power on the performance of parallel connected alternators

4. Synchronous Motors :

4.1 Construction and principle of operation
4.2 Phasor diagram at no load and on load (cylindrical rotor)
4.3 Power equation
4.4 Power angle characteristics
4.5 V - curves and inverted V- curves
4.6 Methods of starting
4.7 Synchronous motor operation at

- 4.7.1 Constant input power and variable excitation
- 4.7.2 Constant excitation and Variable input power

4.8 Synchronous condenser
4.9 Comparison of induction motor and synchronous motor
4.10 Application of synchronous motor

5. Stability Analysis of Synchronous Machines:

5.1 Transient behaviour
5.2 Reactance
5.3 Symmetrical short circuit
5.5 Swing equation, swing curve, M and H constants
5.6 Steady state stability
5.7 Transient stability

5.8 Equal area criterion of stability
5.9 Hunting phenomenon in synchronous machines

6. Special Machines :

6.1 Basic principles, operation, characteristics and applications of following motors -
- 6.1.1 Linear induction motor
- 6.1.2 Stepper motor
- 6.1.3 A.C. Commutator Motors
- 6.1.4 Schrage motor
- 6.1.5 Repulsion motor

PRACTICALS

1. Connecting, starting and reversing the direction of rotation of 3-phase squirrel cage induction motor by using
   - 1.1 D.O.L starter
   - 1.2 Star-Delta starter
2. Speed control of 3-phase induction motor by rotor resistance control.
3. Speed control of 3-phase induction motor by stator voltage control
4. No-load and blocked rotor tests on 3-phase induction motor and plotting of circle diagram.
5. Study the various types of single-phase Induction motor with starting and reversing operation.
6. Starting of synchronous motor and plotting V-curves.
7. Determination of load characteristics of alternator at rated speed.
8. Determination of regulation of alternator by direct loading.
9. Determination of magnetisation curve of an alternator at rated speed
10. O.C and S.C tests on alternator and determination of regulation by synchronous impedance method.
11. Synchronisation of alternators.

REFERENCE BOOKS :

1.	Electrical Machines	I.J. Nagrath
2.	Electrical Technology	B.L.Theraja
3.	Electrical Machines	P.S.Bhimbra
4.	विद्युत इंजीनियरिंग	डी.आर. नागपाल
5.	Electrical Machines	Ashfaq Husain

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POWER SYSTEM - II

CODE EE 307

L	T	P
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RATIONALE

Diploma holders are mostly employed in electricity boards and industries where they are supposed to erect low voltage lines, overhead and underground cables and substation and to erect HV and EHV lines and substation. For doing the above job it is expected that the student are made aware and given practice of the above aspects of lines and substations including safety practices, standardised maintenance schedule, Indian Electricity act and relevant Indian Standards.

As regards design aspects of lines are concerned he should be aware of the various consideration taken into account for this and not actual design. For this design of simple distribution system is needed. It is not only sufficient to construct, operate and maintain a power system but to run it efficiently. For this an engineer should be made aware of the prevailing practices in electricity board which may result in efficient and economical working of the system.

CONTENTS

1. Transmission and Distribution :

- 1.1 Need and basic flow diagram of power system
- 1.2 Relative advantages and disadvantages of A.C and D.C transmission
- 1.3 Selection of transmission voltage
- 1.4 Comparison of A.C. 1-phase, A.C. 3-phase 3 wire and A.C. 3-phase 4 wire on the basis of copper volume for overhead and underground cable
- 1.5 Comparison of D.C. 2-wire and D.C. 3-wire system on the basis of copper volume.

2. Materials used in Overhead Lines :

2.1 Need, requirement, construction and special feature of line supports
2.2 Types of conductors : hollow, stranded and relative merits and demerits
2.3 Selection of size of conductor, general rules used in RSEB for calculation
2.4 Types of insulators, their construction and application
2.5 Potential distribution over a string of insulators
2.6 String efficiency and methods of improving string efficiency

3. Mechanical Design :

3.1 Sag and span
3.2 Sag calculation in overhead lines with same and different level supports
3.3 Effect of wind, ice and temperature on sag
3.4 Effect of sag on overhead conductor configuration and their spacing
3.5 Effect of span on sag
3.6 Stringing chart
3.7 Transposition of conductors

4. Electrical Design:

4.1 Overhead line constants
4.2 Classification of lines
4.3 R, L, C, of over head lines (formula without proof)
4.4 Skin and Ferranti effect

4.5 Calculation of efficiency and regulation for
- 4.5.1 Short transmission line
- 4.5.2 Medium transmission line (T and π methods)
- 4.5.3 Long transmission line

4.6 Generalized circuit constants of transmission line
- 4.6.1 Determination of Generalized circuit constants of
  - 4.6.1.1 Short transmission line
  - 4.6.1.2 Medium transmission line (T and π methods)
  - 4.6.1.3 Long transmission line

5. D.C. Distribution Systems :

5.1 Layout of distribution system, feeders, distributors and service mains
5.2 Radial distributor
5.3 Ring main distributor and with interconnector
5.4 Voltage drop calculation for D.C. distributor for uniform and concentrated loading
- 5.4.1 Radial distributor fed at one end
- 5.4.2 Radial distributor fed at both end with equal and unequal voltages
- 5.4.3 Ring main distributor

6. A. C. Distribution Systems :

6.1 Introduction
6.2 A. C. distributions calculation (ring main & radial feeder)
6.3 Methods of solving A. C. distributions problem
- 6.3.1 Power factor referred to receiving end voltage
- 6.3.2 Power factor to respective load voltage

7. Construction of Underground Distribution Lines :

7.1 Underground cables - types, construction
7.2 Advantages and disadvantages of underground cable
7.3 Selection of LT and HT cables
7.4 Laying of underground cables
7.5 Cable grading and its analysis

8. Construction of Overhead Distribution Lines :

8.1 Survey of LT lines
8.2 Planning of construction work
8.3 Methods of erection of supports
8.4 Erection of conductors - laying out conductors
8.5 Raising and setting of poles, guys, stays
8.6 Fixing of insulators and cross arms
8.7 Guarding.

REFERENCE BOOKS :

1.	Electrical Power	Soni,Gupta & Bhatnager
2.	Electrical Power	J.B.Gupta
3.	Power System	V.K. Mehta
4.	Transmission & Distribution of Electrical Power	Raina & Bhattacharya
5.	Electrical Power	S.L. Uppal
6.	विद्युत शक्ति	डी.आर. नागपाल

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POWER SYSTEM - III

CODE EE 308

L	T	P
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RATIONALE

A diploma holder in electrical engineering has to adopt the cheapest and most convenient scheme for generation and transmission of electrical power. The course content gives full knowledge to learn economic aspects of generation, voltage regulation methods in power system and performance of EHV and HVDC transmission.

CONTENTS

1. Load and Load Curves :

1.1 Types of load
1.2 Variation in demand, chronological load curve
1.3 Load duration curve, energy load curve
1.4 Load factor, capacity factor, diversity factor, connected load, maximum demand, utilization factor

2. Economic Aspects of Generation :

2.1 Factor affecting the cost of generation
2.2 Cost reduction by power station inter connection
2.3 calculation of cost per unit
2.4 Incremental rate of generation and condition for economic loading

3. Tariffs:

3.1 Objectives of tariff
3.2 General tariff form and types of tariff
- 3.2.1 Flat rate
- 3.2.2 Straight meter rate
- 3.2.3 Block meter rate

3.2.4 Hopkinson demand tariff
3.2.5 Doherty demand rate
3.2.6 Wright demand rate
3.3 Present tariff pattern in Rajasthan

4. Power Factor Improvement :

4.1 Meaning of power factor
4.2 Causes of low power factor
4.3 Effects of low power factor
4.4 Advantages of power factor improvement
4.5 Methods of power factor improvement
4.6 Location of shunt capacitors

5. Combined Operation of Power Stations :

5.1 Types and advantage of interconnection
5.2 Base load, peak load and load allocation among different power station
5.3 Real and reactive power control of turbo alternator
5.4 Reactive power requirements during peak and off peak hours

6. Control of Voltage and Reactive Power :

6.1 Introduction
6.2 Methods of voltage control
6.3 Tap changing transformers
6.3.1 Offload tap changing transformer
6.3.2 On load tap changing transformer
6.4 Shunt reactors
6.5 Shunt capacitors
6.6 Series compensation
6.7 Location of series capacitors
6.8 Protective schemes for series capacitors
6.9 Problems associated with series capacitors
6.10 Series capacitor versus shunt capacitor
6.11 Synchronous phase modifiers
6.11.1 Rating of a phase modifier
6.12 Static VAr systems (SVS)
6.13 Advantages and applications of SVS

7. Extra High Voltages Transmission :

7.1 Introduction
7.2 Need for EHV transmission
7.3 Use of Bundled conductors
7.4 Conductor surface gradients
7.5 Environmental aspects in EHV and UHV lines design
7.6 Radio noise from EHV lines

8. HVDC Transmission :

8.1 Introduction
8.2 Types of DC links
8.3 Advantages of DC transmission
8.4 Converter station equipment
8.5 Ground return
8.6 Earth electrode, station earth
8.7 HVDC systems in India

9. Corona :

9.1 The Phenomenon of Corona
9.2 Disruptive critical voltage
9.3 Visual critical voltage
9.4 Corona Loss
9.5 Factors and conditions affecting corona
9.6 Raido interference due to corona
9.7 Practical considerations
9.8 Corona in Bundled conductor

REFERENCE BOOKS :

1. Generation of Electrical Energy — B.R. Gupta
2. Power System Design — M.V. Despandey
3. Electrical Power System — Nagrath & Kothari
4. Elements of Power system — Stevension
5. Power System Analysis and Design — B.R. Gupta
6. Electrical Power Systems — Ashfaq Husain

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SWITCHGEAR AND PROTECTION

CODE EE 309

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RATIONALE

The course is designed to develop the understanding of the principles and working of protective switchgears so that one can handle, install and maintain them and also take decisions at his level in different situations.

After undergoing this course the engineer is suitable to work at power station, high voltage lab and sub station etc.

CONTENTS

1. Faults in Power System :

1.1 Sources of faults
1.2 Percentage reactance and base KVA
1.3 3-phase short circuits on alternator
1.4 Calculations of short-circuit KVA current
1.5 Construction of reactors
1.6 Limitations of fault current
1.7 Location of reactor

2. Symmetrical Components :

2.1 Operator 'a'
2.2 Determination of sequence components
2.3 Sequence impedance and sequence network
2.4 Types of faults at the terminals of unloaded alternator
2.5 Determination of fault current

3. Fuses :

3.1 Definition of different terms
3.2 Selection of fuse materials
3.3 Types of fuses
3.4 Application of H.R.C. fuses
3.5 Drop out fuse
3.6 Advantage and disadvantage of fuses

4. Circuit Breakers :

4.1 Basic construction of circuit breaker
4.2 Arc phenomenon
4.3 Arc extinction methods
4.4 Interruption of capacitive current
4.5 Current chopping
4.6 Resistance switching
4.7 Construction, working and application of

4.7.1 Oil circuit breaker

4.7.1.1 Bulk oil C.B.
4.7.1.2 Minimum oil C.B.

4.7.2 Air Circuit breaker
4.7.3 Air blast circuit breaker
4.7.4 Vacuum circuit breaker
4.7.5 SF_6 circuit breaker

4.8 Ratings of circuit breaker

5. Protection :

5.1 Principle of protection systems
5.2 Basic requirement of relays
5.3 Classification of relays according to construction, uses and operating time
5.4 Types o f relays (construction, setting and applications)

5.4.1 Thermal relay
5.4.2 Electromagnetic relay
5.4.3 Induction type relay
5.4.4 Differential type relay
5.4.5 Distance relay

5.5 Over current, reverse power and earth leakage protection
5.6 Static relays

5.6.1 Basic elements
5.6.2 Applications

6. Protection of Alternator :

6.1 Field failure
6.2 Field earth fault
6.3 Over current
6.4 Phase unbalance and insulation protection
6.5 Differential and restricted earth fault schemes
6.6 Protection against prime mover failure

7. Transformer Protection :

7.1 Over current
7.2 Earth fault
7.3 Differential protection
7.4 Buchholz relay
7.5 Differential scheme for the protection of generator - transformer units.

8. Line Protection :

8.1 Differential pilot wire protection systems
8.2 Time graded directional over current and earth fault protection
8.3 Elements of distance protection and power line carrier protection

9. Over Voltage Protection :

9.1 Causes of over voltage
9.2 Lightning surges
9.3 Protection of line against over voltage
9.4 Function of ground wire
9.5 Horn gap
9.6 Lightening arrestors
9.7 Insulation coordination

REFERENCE BOOKS :

1. Switchgear & Protection — Sunil S.Rao
2. A Course in Electrical Power — Soni, Gupta & Bhatnagar
3. Switchgear & Protection — M.Chander & Ravindranath
4. Electrical Power System — C.L. Wadhwa.

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ENERGY MANAGEMENT

CODE EE 310

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RATIONALE

To achieve the target and goals in an organisation it is essential to co-ordinate the entire system. For this purpose a diploma holder should have the knowledge of principles of electrical energy management, auditing and environmental aspects.

CONTENTS

1. Energy Management and Energy Planning :

1.1 Definitions and Significance
1.2 Energy Strategy, Energy Policy and Energy Planning
1.3 Two Sides of Energy Management
1.4 Sectors of Supply Side Energy Management
1.5 Objectives of Energy Management
1.6 Hierarchical Levels of Sup-- Side Energy Management
1.7 Trade-off between Energy and Environment
1.8 Finery- and Energy Planning
1.9 Energy and Economy
1.10 Essential Imperatives and Steps in Supply Side Energy Planning
1.11 Energy Planning Flow for Supply Side
1.12 Essential Data for Supply-side Energy Planning
1.13 Per Capita Energy Consumption
1.14 Essential Imperatives and Steps in User Side Energy Planning
1.15 Energy Management and Control Systems (EMCs or EMS) for Demand Side
1.16 Energy Management in End-User Plant
1.17 Seven Principles of Energy Management
1.18 Energy Policy of a Supply Organization and Demand Side Organization
1.19 Energy Policy of a Demand Side Organization (Energy Consumer)
1.20 Organization for Energy Management

2. Energy and Power Management :

2.1 Overview of India's Energy and Power Sector
2.2 National Energy Strategies of India
2.3 Primary Energy Sources for Power Generation and
2.4 Electric Power Sector Planning in India
2.5 India's Nonconventional, Renewable arid Alternate Energy Planning
2.6 Rural Electrification Programs in India
2.7 Economic Reforms in Energy and Power Sector
2.8 Energy Consumption Trends in India, Integrated Estimates
2.9 Energy Conservation Measures under 9th Five Year Plan
2.10 Per Capita Availability of Commercial Energy Resources, Reserve to Production Ratio (R/P)

3. Energy Audit :

3.1 Aim of Energy Audit
3.2 Energy flow diagram
3.3 Strategy of Energy Audit
3.4 Comparison with Standards
3.5 Energy Management Team
3.6 Considerations in Implementing Energy Conservation programmes
3.7 Periodic progress review
3.8 Instruments for energy audit
3.9 Energy Audit of illumination system
3.10 Energy audit of electrical system
3.11 Energy audit of Heating, ventilation and Air conditioning systems
3.12 Energy audit of compressed air system
3.13 Energy audit of buildings
3.14 Energy Audit of steam Generation, Distribution and utilization system
3.15 Economic analysis

4. Energy Conversation :

4.1 Introduction
4.2 Motivation for Energy Conservation
4.3 Principles of Energy Conservation
4.4 Energy Conservation planning
4.5 Energy Conservation in following sectors
  4.5.1 Industries
  4.5.2 Electrical Generation, Transmission and distribution
  4.5.3 Household and commercial sectors
  4.5.4 Transport
  4.5.5 Agriculture
4.6 Energy Conservation Legislation

5. Environmental Aspects of Energy and Pollution Control :

5.1 Introduction
5.2 Terms and Definitions
5.3 Pollution from use of energy
5.4 Combustion products of fossil fuels
5.5 Particulate matter
5.6 Fabric filter and Baghouse
5.7 Electro-static precipitator (ESP)
5.8 Carbon Dioxide
5.9 Green house effect and Global arming
5.10 Emission of Carbon Monoxide
5.11 Pollution by Sulphur dioxide (SO_2) and Hydrogen Sulphide H_2S
5.12 Emission of Nitrogn Oxides
5.13 Acide Rains, Acid Snow, Acidic Fog and Dry Acidic Deposits
5.14 Acid Fog
5.15 Dry Acidic Deposition

5.16 FGD and SCR Systems of Cleaning Flue Gases

6. Energy and Sustainable Development :

6.1 Introduction
6.2 Energy problems
6.3 Energy use trends in Developing countries
6.4 Prospects of changes in Energy supply
6.5 Agenda for Sustainable development

REFERENCE BOOKS :

1. Generation of Electrical Energy — B.R. Gupta
2. Energy Technology — S.Rao,Dr.B.B.Parullkar
3. An Overview of Environment Engineering — Kapoor

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