

SWITCHGEAR & PROTECTION (ELECTRICAL ENGINEERING GROUP)

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|---------------------------------|--------------------------------|----------|------------|-------------------|----------|------------|----------------|
| Subject Code 1620501 | Theory | | | | | | Credits |
| | No. of Periods Per Week | | | Full Marks | : | 100 | 04 |
| | L | T | P/S | ESE | : | 70 | |
| | 04 | — | — | TA | : | 10 | |
| | — | — | — | CT | : | 20 | |

CONTENTS: THEORY

| | Name of the Topic | Hours | Marks |
|----------------|--|--------------|--------------|
| Unit-01 | Fundamental: 1.1 Necessity & functions of protective system. 1.2 Normal & abnormal conditions. 1.3 Types of faults & their causes. 1.4 Short circuit calculations(Symmetrical faults only) 1.5 Use of current limiting reactors & their arrangements. | 05 | 08 |
| Unit-02 | Circuit interrupting devices 2.1 HRC fuses – construction, types, working, characteristics, selection and applications 2.2 Isolators- vertical break, horizontal break & pentograph type 2.3 Arc formation process, methods of arc extinction, related terms. 2.4 Circuit breakers- Concept, Classification, Working principle, Construction, Specification & Applications of 2.4.1 H.T – Bulk oil circuit breaker, Minimum oil circuit breakers (M.O.C.B.), Sulpher Hexa Fluoride circuit breaker (SF ₆). vacuum circuit breaker. 2.4.2 L.T.- Air circuit breakers (ACB),miniature circuit breakers (M C B) , Moulded case circuit breakers (M C C B) , Earth leakage circuit breaker (E L C B or R L C B), Comparison of fuse & MCCB 2.5 Selection of MCCB for motor. 2.6 Selection and rating of circuit breakers. | 12 | 14 |
| Unit-3 | Protective Relaying 3.1 Requirements- relay time, related terms. 3.2 Classification – Electromagnetic attraction, induction static , μ P based relays. 3.3 Protective transformers. (No numerical on above topic.) 3.4 Over current relay-Time current characteristics. 3.5 Static over current relays 3.6 μ P based over current relays. 3.7 Distance relaying- Principle, static, μ P based 3.8 Directional relay. 3.9 Differential Relay. (Simple numerical on relay setting) | 12 | 12 |
| Unit-4 | Protection of Alternator 4.1 Abnormalities & Faults 4.2 Differential protection 4.3 Overcurrent , earth fault, interturn fault, negative phase sequence, over heating protection. 4.4 Reverse power protections. (Simple numerical on differential protection) | 08 | 08 |

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|---------------|--|-----------|-----------|
| Unit-5 | Protection of Transformer 5.1 Abnormalities & faults. 5.2 Differential, over current, earth fault, interturn, restricted earth fault, over heating protection. 5.3 Buchholtz relay (Simple numerical on differential protection) | 08 | 08 |
| Unit-6 | Protection of Motor 6.1 Abnormalities & faults. 6.2 Short circuit protection, Overload protection, Single phase preventor | 04 | 05 |
| Unit-7 | Protection of Busbar & transmission line 7.1 Abnormalities & faults. 7.2 Bus bar protection. 7.3 Transmission line, over current, distance protection. Pilot wire protection | 06 | 08 |
| Unit-8 | Neutral Earthing 8.1 Introduction & importance. 8.2 Types of earthing 8.3 substation earthing | 03 | 03 |
| Unit-9 | Over voltage Protection 9.1 Causes of over voltages. 9.2 Lighting phenomena & over voltage due to lightning. 9.3 Protection of transmission line & substation from direct stroke. 9.4 Types of lightning arresters & surge absorbers & their Construction & principle of operation. 9.5 Protection against traveling waves. 9.6 Insulation co-ordination. | 06 | 04 |
| | Total | 64 | 70 |

| Text /Reference Books: | | |
|--|-----------------------------|------------------------------|
| Titles of the Book | Name of Authors | Name of the Publisher |
| Switch gear & protection | S.Rao. | Khanna Publications, New |
| A text book on electrical power system | Soni,Gupta & Bhatnagar. | Dhnapat Rai & Sons, New |
| The art & science of protective relaying | Mason C.R. | ----- |
| A text book of Electrical power | S.L.Uppal. | Khanna Publisher, Delhi. |
| Power System Protection & Switchgear | Badriram & Vishwakarma P.N. | TMH, New Delhi |
| Switchgear & Power system Protection | Ravindra P. Singh | PHI Publication |
| Handbook of Switchgears | BHEL | Tata McGraw Hill |
| Switchgear and Protection | Prabhat Kumar | Foundation Publishing |

A. C. MACHINES (ELECTRICAL ENGINEERING GROUP)

| | | | | | | | |
|---------------------------------|--------------------------------|----------|------------|-------------------|----------|------------|----------------|
| Subject Code 1620502 | Theory | | | | | | Credits |
| | No. of Periods Per Week | | | Full Marks | : | 100 | 04 |
| | L | T | P/S | ESE | : | 70 | |
| | 04 | — | — | TA | : | 10 | |
| | — | — | — | CT | : | 20 | |

CONTENTS: THEORY

| | Name of the Topic | Hours | Marks |
|--|--|-------|-------|
| Unit-01 | Three phase induction motor | 13 | 14 |
| | 1.1 Construction of three phase induction motor | | |
| | 1.2 Production of rotating magnetic field | | |
| | 1.3 Principle of working/operation | | |
| | 1.4 Concept of slip | | |
| | 1.5 Equation of rotor induced emf, current, frequency, reactance, and impedance under steady and running condition | | |
| | 1.6 Torque equation of three phase induction motor | | |
| | 1.7 Starting and running torque of squirrel cage and slip ring induction motor | | |
| | 1.8 Condition for maximum and starting torque | | |
| | 1.9 Torque slip characteristics of three phase induction motor | | |
| 1.10 Effect of change in rotor circuit resistance on torque-slip characteristics | | | |
| 1.11 Effect of change in supply voltage on torque-slip characteristics | | | |
| 1.12 measurement of slip by | 13 | 14 | |
| a) Tachometer method | | | |
| b) Comparing rotor frequency and stator frequency | | | |
| 1.13 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 | | | |
| 1.14 Comparison between squirrel-cage and slip-ring induction motor. | | | |
| 1.15 Applications of three phase induction motor. | | | |
| 1.16 Power stages of three phase induction motor. | | | |
| 1.17 Double cage IM | 07 | 08 | |
| a) Construction | | | |
| b) Characteristic of outer, inner cage & combined characteristic | | | |
| c) Industrial Applications (Numerical on all above) | | | |
| 1.18 I.M. as a generalized transformer | | | |
| 1.19 Vector diagram of IM | | | |
| 1.20 Equivalent circuit of 3-phase IM (No numerical) | 07 | 08 | |
| 1.21 Starting of 3-phase IM (No numerical) | | | |
| a) Stator resistance starter | | | |
| b) Star-Delta starter | | | |
| c) Auto transformer starter | | | |
| d) Rotor resistance starter | | | |

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|----------------|---|-----------|-----------|
| Unit-02 | Three Phase Alternator | 12 | 14 |
| | 2.1 Definition and construction of three phase Alternator a) Armature b) Rotor- smooth cylindrical & projecting type | | |
| | 2.2 Derivation of e.m.f. equation of Alternator which includes a) Chording factor b) Distribution factor | | |
| | 2.3 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 impedance | | |
| | 2.4 Regulation of three phase Alternator by a) Synchronous impedance method b) mmf method (Numerical on all above) | | |
| Unit-03 | Synchronous Motor | 12 | 13 |
| | 3.1 Principle of working/operation | | |
| | 3.2 Synchronous Motor on load with constant excitation | | |
| | 3.3 Effect of excitation at constant load | | |
| | 3.4 V curve & inverted V curve | | |
| | 3.5 Hunting & phase swinging | | |
| | 3.6 Applications | | |
| | 3.7 Starting of Synchronous Motor | | |
| | 3.8 Comparison between IM & Synchronous Motor (Numerical on all above) | | |
| Unit-04 | Single phase Motors | 07 | 07 |
| | 4.1 Types of Single phase IM | | |
| | 4.2 Split phasing principle of starting a) Resistance start induction run b) Capacitor start induction run c) Capacitor start Capacitor run d) Double value Capacitor applications motor | | |
| | 4.3 Shaded pole IM | | |
| | 4.4 Applications | | |
| | | | |
| Total | | 64 | 70 |

| Text / Reference Books: | | |
|--------------------------------|--------------------------|----------------------------------|
| Titles of the Book | Name of Authors | Name of the Publisher |
| Electrical Machines | S. K. Bhattacharya | TTTI, Chandigarh |
| Electrical Technology Vol. II | B. L. Theraja | S chand & Co. |
| Electrical engineering | C.L.Dawes | T. M. G. H. |
| <i>Electrical Machinery</i> | Dr.P.S. Bimbira | Khanna Publishers, New Delhi. |
| <i>Electrical Machines</i> | M.V.Deshpande | PHI Learning Pvt.Ltd, New Delhi. |
| <i>Electrical Machines</i> | D.P.Kothari, I.J.Nagrath | Tata McGraw Hill |
| <i>A.C. Machines</i> | Shalini Verma | Foundation Publishing |

UTILIZATION OF ELECTRICAL ENERGY (ELECTRICAL ENGINEERING GROUP)

| | | | | | | | |
|---------------------------------|--------------------------------|----------|------------|-------------------|----------|------------|----------------|
| Subject Code 1620503 | Theory | | | | | | Credits |
| | No. of Periods Per Week | | | Full Marks | : | 100 | 04 |
| | L | T | P/S | ESE | : | 70 | |
| | 04 | — | — | TA | : | 10 | |
| | — | — | — | CT | : | 20 | |

CONTENTS: THEORY

| | Name of the Topic | Hour | Mark |
|----------------|---|------|------|
| Unit-01 | <p>Illumination:</p> <p>1.1 Definitions of Terms Used in Illumination: Light, Luminous Flux, Luminous Intensity, Lumen, Candle Power, Illumination, Lux or Meter Candle, Mean Horizontal Candle Power (MHCP), Mean Spherical Candle Power (MSCP), Mean Hemi-spherical Candle Power (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.</p> <p>1.2 Laws of Illumination:</p> <ul style="list-style-type: none"> - Law of Inverse Squares - Lambert's Cosine Law. (No Numerical) <p>1.3 Sources of Light: Construction, Working and Applications of Following Lamps:</p> <ul style="list-style-type: none"> - Incandescent Lamps. - Halogen Lamps. - Low Pressure Mercury Vapour Lamps (Fluorescent Tube). - High Pressure Mercury Vapour Lamps. - Sodium Vapour Lamps. - Compact Fluorescent Lamps (C.F.L.) - Metal Halide Lamps - LED Lamps - Neon Signs. <p>1.4 – Basic Principles of Light Control.</p> <p>1.5 – Types of Lighting Schemes. Direct, Semi-direct, Semi-indirect, Indirect, General Lighting.</p> <p>1.6 – Design of Lighting Scheme: Objectives of Lighting Scheme. Factors to be considered While Designing the Lighting Scheme. (Simple Numericals)</p> <p>1.7 - Factory Lighting:</p> <ul style="list-style-type: none"> - General Requirements - Types of Installations: General Lighting, Local Lighting, Emergency Lighting. <p>1.8 – Lumen or Light Flux Method of Lighting Calculations. (Simple Numericals)</p> <p>1.9 – Flood Lighting</p> <ul style="list-style-type: none"> - Flood Lighting Purposes. - Classification of Projectors. - Location and Mounting of Projectors. (Simple Numericals) | 14 | 14 |

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|---------|--|----|----|
| Unit-02 | <p>Electric Heating and Welding: Electric Heating:</p> <p>2.1.1– Advantages of Electric Heating.</p> <p>2.1.2 – Modes of Transfer of Heat:</p> <ul style="list-style-type: none"> - Conduction, Convection and Radiation. <p>2.1.3 – Classification of Electric Heating Methods:</p> <p>2.1.4 – Resistance Heating:(Construction & Operation)</p> <ul style="list-style-type: none"> - Direct Resistance Heating: Salt Bath Furnace. - Indirect Resistance Heating: Resistance Ovens, Requirements of Heating Element Material, Causes of Failure of Heating Elements, Methods of Temperature Control. - Applications of Resistance Heating. <p>2.1.5 – Arc Heating: (Construction & Operation)</p> <ul style="list-style-type: none"> - Direct Arc Furnace: - Indirect Arc Furnace. - Applications of Arc Heating. <p>2.1.6 –Induction Heating: (Construction & Operation)</p> <ul style="list-style-type: none"> - Core Type Induction Furnaces: Ajax Wyatt Furnace. - Coreless Induction Furnace. - Applications of Induction Heating. (Simple Numericals on Melting Furnaces) <p>2.1.7 – Dielectric Heating:</p> <ul style="list-style-type: none"> - Principle of Dielectric Heating. - Advantages of Dielectric Heating - Limitations of Dielectric Heating. - Applications of Dielectric Heating. (Simple Numericals on Dielectric Heating) <p>Electric Welding:</p> <p>2.2.1– Methods of Electric Welding: Electric Arc Welding, Resistance Welding.</p> <p>2.2.2 – Resistance Welding:</p> <ul style="list-style-type: none"> - Principle of Resistance Welding. - Advantages of Resistance Welding. - Types of Resistance Welding - (Only List) <p>2.2.3 – Spot Welding Machine.</p> <p>2.2.4 – Electric Arc Welding:</p> <ul style="list-style-type: none"> - Formation and Characteristics of Electric Arc. - Effect of Arc Length. - Arc Blow. <p>2.2.5 – Polarity in DC Welding:</p> <p>2.2.6 – Electrodes for Metal Arc Welding:</p> <p>2.2.7 – V-I Characteristics of Arc Welding DC Machines.</p> <p>2.2.8 – Arc Welding Machines:</p> <ul style="list-style-type: none"> - DC Welding Machines – MG Set, AC Rectified Welding Unit. - AC Welding Machines – Welding Transformer. | 16 | 10 |
| Unit-03 | <p>Elevators:</p> <p>3.1 Types of electric elevators</p> <p>3.2 Size and shape of elevator car</p> <p>3.3 Speed of elevators</p> <p>3.4 Location of elevator machine</p> <p>3.5 Types of elevator machines, elevator motors</p> <p>3.6 Power transmission gears braking</p> <p>3.7 Safety in elevators</p> <p>3.8 Bombay lift act.</p> | 08 | 08 |

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|----------------|--|-----------|-----------|
| Unit-04 | Electric Drives: | | |
| | <p>4.1 – Introduction:</p> <ul style="list-style-type: none"> - What is drive? - Drives – Mechanical Drive and Electric Drive. <p>4.2 – Advantages and Disadvantages of Electric Drive.</p> <p>4.3 – Factors Governing Selection of Electric Motors.</p> <p>4.4 - Nature of Electric Supply: 3 ϕ & 1ϕ AC and DC.</p> <p>4.5 - Type of Drive: Group Drive & Individual Drive.</p> <p>4.6 - Nature of Load: Nature of the Mechanical Load, Matching of the Speed Torque Characteristics of the Motor with that of the Load, and Starting Conditions of the Load.</p> <p>4.7 - Electrical Characteristics: (Only DC Series, Three Phase and Single Phase Induction Motors are to be dealt)</p> <ul style="list-style-type: none"> - Running Characteristics: Three Typical Speed Torque Characteristics – Inverse, Constant Speed and Drooping. - Starting Characteristics: Starting Torque only. (No Starters). - Speed Control: Suitability to Economic and Efficient Speed Control Methods (Above and Below Normal Speed). - Braking Characteristics: Plugging, Rheostatic Braking and Regenerative Braking, as Applied to DC Series and Three Phase Induction Motor. <p>4.8 - Mechanical Features:</p> <ul style="list-style-type: none"> - Type of Enclosure as per IS - Type of Bearings - Type of Transmission for Drive - Noise Level. <p>4.9 - Size of Motor:</p> <ul style="list-style-type: none"> - Load Conditions – Continuous Loads, Short Time Loads, Intermittent Loads, Continuous Operation with Short Time Loads and Continuous Operation with Intermittent Loads. - Duty Cycles. - Standard Ratings for Motors as per ISS. - Estimation of Rating of a Motor. (Simple Numericals on Estimating Size of Continuously Rated Motor) - Load Equalisation. (No Calculations) <p>4.10 - Cost:</p> <ul style="list-style-type: none"> - Capital Cost - Running Cost (Losses, p.f., Maintenance). | 16 | 18 |
| Unit-05 | Economic Aspects of Utilising Electrical Energy: | | |
| | <p>6.1 – Economic Aspects of Utilising Electrical Energy.</p> <p>6.2 – Costing of Electrical Energy: Fixed Charges, Semi Fixed Charges and Running Charges.</p> <p>6.3 – Formulation of Electrical Tariffs.</p> <p>6.4 – Various Types of Tariffs: Tariffs in force for Domestic, Commercial and Industrial Consumers.</p> <p>6.5 – 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. Automatic Power Factor Controller (Derivation and Simple Numerical)</p> <p>6.6 – Energy Conservation: Importance and need of Energy Conservation, Measures for Energy Conservation in (i) Electric Drives (ii) Electric Traction (iii) Electric Heating (iv) Refrigeration and Air Conditioning (v) Illumination.</p> | 10 | 10 |
| | Total | 64 | 70 |

| Text / Reference Books: | | |
|--|--|------------------------------|
| Titles of the Book | Name of Authors | Name of the Publisher |
| Art & Science of Utilisation of Electrical Energy | H. Partab | Dhanpat Rai & Sons |
| Utilisation of Electric Power & Electric Traction. | J. B. Gupta | S. K. Kataria & Sons |
| Utilisation of Electric Power & Electric Traction. | G. C. Garg | Khanna Publishers |
| Electric Traction | J. Upadhyay S. N. Mahendra | Allied Publisher Ltd. |
| Fundamentals of Electrical Drives | G. K. Dubey | Narosa Publishing House. |
| Generation & utilization of Electrical Energy | S. Shrivnagaraju, M. Balasubba Reddy, D. Srilatha | Pearson Publications |
| Utilization of Electrical Energy | E. Openshaw Taylor | Orient Longman Pvt. Ltd. |
| Utilization of Electrical Energy | Rajiv Ranjan | Foundation Publishing |

ELECTRIC TRACTION-I (ELECTRICAL ENGINEERING GROUP)

| | | | | | | | |
|---------------------------------------|--------------------------------|----------|------------|-------------------|----------|------------|----------------|
| Subject Code 1620504 | Theory | | | | | | Credits |
| | No. of Periods Per Week | | | Full Marks | : | 100 | 03 |
| | L | T | P/S | ESE | : | 70 | |
| | 03 | — | — | TA | : | 10 | |
| | — | — | — | CT | : | 20 | |

CONTENTS: THEORY

| Chapter | Name of the Topic | Hours | Marks |
|----------------|--|-------|-------|
| Unit-01 | Power Supply Arrangements: 1.1 – Introduction 1.2 – High Voltage Supply. 1.3 – Constituents of Supply System. Substations. Feeding Posts. Feeding and Sectioning Arrangements. Sectioning and Paralleling Post. Sub sectioning and Paralleling Post. Sub sectioning Post. Elementary Section. Miscellaneous Equipments at Control Post or Switching Stations. 1.4 – Major Equipments at Substation. Transformer. Circuit Breaker. Interrupter. Protective System for AC Traction – Transformer Protection and 25 KV Catenary Protection 1.5 – Location and Spacing of Substations. | 12 | 18 |
| Unit-02 | Overhead Equipments: 2.1 – Overhead Equipments (OHE). 2.2 – Principles of Design of OHE: Composition of OHE. Height of Contact Wire. Contact Wire Gradient. Encumbrances. Span Length. 2.3 – Automatic Weight Tension and Temp. Compensation. 2.4 – Uninsulated Overlaps. 2.5 – Insulated Overlaps. 2.6 – Neutral Section. 2.7 – Section Insulator. 2.8 – Isolator. 2.9 – Polygonal OHE: Single Catenary Construction. Compound Catenary Construction. Stitched Catenary Construction. Modified Y Compound Catenary. 2.10 – Effect of Speed on OHE. 2.11 – OHE Supporting Structure. 2.12 – Different types of signal boards of OHE. 2.13 – Maintenance of OHE: - OHE Maintenance Schedule. (No Derivation and No Numerical) | 12 | 14 |

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| Unit-03 | Current Collecting Equipments: 3.1 – Introduction. 3.2 – Systems of Supplying Power in Electric Traction: Third Rail or Conductor Rail System. Overhead System. 3.3 – Current Collectors for Overhead System: - Trolley Collector or Pole Collector, Bow Collector, Pantograph Collector. 3.4 – Types of Pantographs: Diamond Pantograph and Faiveley Type. 3.5 – Construction of Faiveley Type Pantograph. 3.6 – Methods of Raising and Lowering of Pantograph. 3.7 – Maintenance of Pantograph. | 08 | 14 |
| Unit-04 | Signalling and Supervisory Control: 4.1 – Requirements of Signalling System 4.2 – Types of Signals. 4.3 – Colour Light Signals. 4.4 – Three and Four Aspects of Colour Light Signals. 4.5 – Track Circuits. 4.6 – DC Track Circuit. 4.7 – AC Track Circuit. 4.8 – Supervisory Control: Introduction. Advantages of Remote Control. Systems of Remote Control: DC versus Voice Frequency (VF) Signalling. Remote Control System Equipment and Network. Mimic Diagram. Control Desk for TPC. Remote Control Switching Equipments. The F.M.V.F.T. Power Supply. Controlled Station Equipments. | 08 | 14 |
| Unit-05 | Train Lighting: 5.1 – Systems of Train Lighting. 5.2 – Special Requirements of Train Lighting. 5.3 – Method of obtaining Unidirectional Polarity. 5.4 – Method of obtaining Constant Output. 5.5 – Single Battery System. 5.6 – Double Battery Parallel Block System. 5.7 – Failure of Under frame Generating Equipments. 5.8 – End on Generation. 5.9 – Railway Coach Air Conditioning: - Requirements. - Types of Installations. - Air Conditioned Rolling Stock. 5.10 – Air Conditioning Equipments on Coaches. | 08 | 10 |
| | Total | 48 | 70 |

Text / Reference Books:

| Titles of the Book | Name of Authors | Name of the Publisher |
|---|----------------------------|------------------------------|
| Modern Electric Traction | H. Partab | Dhanpat Rai & Sons |
| Electric Traction | J. Upadhyay S. N. Mahendra | Allied Publishers Ltd. |
| Viddut Engine Parichay (In Hindi) | Om Prakash Kesari | S. P. Graphics, Nashik. |
| Electric Traction –Motive Power and Energy supply | Andreas Steimel | Oldenbourg-indstrierlag |
| Electric Traction-I | Deepak Srivastava | Foundation Publishing |

INDUSTRIAL AUTOMATION (ELECTRICAL ENGINEERING GROUP)

| | | | | | | | | |
|---------------------------------------|--------------------------------|----------|------------|-------------------|-----------|------------|-----------------------------|--|
| Subject Code 1620505 | Theory | | | | | | Credits 03 | |
| | No. of Periods Per Week | | | Full Marks | | | | |
| | L | T | P/S | ESE | : | 100 | | |
| | 03 | — | — | TA | : | 70 | | |
| | — | — | — | CT | : | 10 | | |
| | | | | | 20 | | | |

CONTENTS: THEORY

| Chapter | Name of the Topic | Hours | Marks |
|---------------|---|-----------|-----------|
| Unit-1 | Automation 1.1 Need of automation 1.2 Advantages of automation 1.3 Requirements of automation | 02 | -- |
| Unit-2 | Control System 2.1 Concept of control system 2.2 Basic block diagram of control system 2.3 Transfer function 2.4 Block diagram reduction Techniques. 2.5 Types of control system 2.6 Applications of control system | 04 | 08 |
| Unit-3 | Control System Components & Electrical Actuators 3.1 I/P devices- switches-push buttons, foot switch, selector switch, pilot switch, proximity Switch. 3.2 Sensors 3.3 Relays [Electro mechanical, reed] 3.4 Valves, pilot lamps, contactors 3.5 Potentio meter- working uses as error detector 3.6 Servo motors - AC & DC working Principle. 3.7 Synchros- Transmitter & control transformer 3.8 Tacho generator- working Principle 3.9 Stepper motor (Permanent magnet & Variable reluctance)- working Principle 3.10 Power & control circuits for different applications like hoist, ganes, comeyer belt etc. | 16 | 30 |
| Unit-4 | Controllers & Control Actions 4.1 Electric & Electronic Controllers & Lead lag networks. 4.2 Digital controllers :- Brief overview of microprocessor & microcontroller to be worked as controller 4.3 P, I P+I, P+D, P+I+D actions. 4.4 P+I+D action using hydraulic pneumatic & electronic controller 4.5 Tacho - generator | 14 | 20 |
| Unit-5 | Programmable logic Controller 5.1 Introduction 5.2 Advantages & disadvantages. 5.3 PLC vs PC 5.4 Block diagram of PLC | 10 | 12 |
| Unit-6 | Introduction to special control system 6.1 Distribution control system (DCS)- brief introduction to hardware & Software used. | 02 | |
| Total | | 48 | 70 |

| Text / Reference Books: | | |
|---|-----------------------------------|------------------------------|
| Titles of the Book | Name of Authors | Name of the Publisher |
| Control System Engg. | Nagrath Gopal | Wiley Eastern |
| Modern Control Engg. | Ogata | Prentice Hall |
| Industrial Control Engg | Jacob | Prentice Hall |
| Hydraulics & Pneumatics | Andrew Parr | Jaico Publication |
| Programmable Logic Controller: Principle applications | Webb & Reis | Wiley Eastern |
| Control of Electrical Machines | S.K. Bhattacharya Brijinder Singh | New Age International |
| Industrial automation and process control | Jon stenerson | Prentice Hall |
| Handbook of Industrial automation | Richad Shell | Taylor and Francis |
| Industrial Automation | Balakrishnan | Foundation Publishing |

SWITCHGEAR AND PROTECTION LAB (ELECTRICAL ENGINEERING GROUP)

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|---------------------------------------|--------------------------------|----------|------------|-----------------|----------|-----------|-----------------------------|
| Subject Code 1620506 | Practical | | | | | | Credits 01 |
| | No. of Periods Per Week | | | | | | |
| | L | T | P/S | ESE | : | 50 | |
| | — | — | 02 | Internal | : | 15 | |
| | — | — | — | External | : | 35 | |

CONTENTS: PRACTICAL

Skills to be developed:

Intellectual Skills:

5. Identify different types of circuit breakers
6. Identify various faults on the system
7. Calculate the fault levels

Motor Skills:

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

List of Practical:

- 1) Identify the components of different types of circuit breakers with their specifications (through visits, video or model).
 - I) Low tension air circuit breaker.(including protective devices)
 - II) Minimum oil circuit breaker (M O C B)
 - III) Miniature circuit breaker (M C B)
 - IV) Moulded case circuit breaker (M C C B)
 - V) Earth Leakage circuit breaker (E L C B) or Residual leakage circuit breaker (R L C B)
 - VI) Sulphur - Hexa fluoride circuit breaker (S F 6)
 - VII) Vacuum circuit breaker.
- 2) Plot performance characteristics of over current relay.
- 3) Simulation of alternator protection.
- 4) Simulation of transformer protection.
- 5) Comparative study of specifications of earthing at different substations / different locations & new trends in earthing schemes (information search)
- 6) Comparative study of specification of lightning arresters of different manufacturers through Brochures / Literature
- 7) For a given 3-ph induction motor with D.O.L. starter
 - a. Check the operation of over current relay for various loads.
 - b. Check the operation of single phasing preventer by creating single phasing fault.
 - c. Check the operation of D.O.L. starter under short circuit condition.

List of Laboratory Experiments :

| | |
|---|---|
| 1 | To identify given 3-ph induction motor with D.O.L. starter <ol style="list-style-type: none"> a. Check the operation of over current relay for various loads. b. Check the operation of single phasing preventer by creating single phasing fault. Check the operation of D.O.L. starter under short circuit condition. |
| 2 | Plot performance characteristics of over current relay. |
| 3 | To perform an experiment on Simulation of <ol style="list-style-type: none"> A. Alternator protection. B. Transformer protection. |
| 4 | Comparative study of specifications of earthing at different substations / different locations & new trends in earthing schemes (information search) |
| 5 | Comparative study of specification of lightning arresters of different manufacturers through Brochures / Literature |
| 6 | Explain the different types of circuit breakers with their specifications |

A.C. MACHINES LAB (ELECTRICAL ENGINEERING GROUP)

| | | | | | | | |
|---------------------------------------|--------------------------------|----------|------------|-------------------|----------|-----------|----------------|
| Subject Code 1620507 | Practical | | | | | | Credits |
| | No. of Periods Per Week | | | Full Marks | : | 50 | 01 |
| | L | T | P/S | ESE | : | 50 | |
| | — | — | 02 | Internal | : | 15 | |
| | — | — | — | External | : | 35 | |

CONTENTS: PRACTICAL

Intellectual Skills: 1. Analytical Skills
2. Identification

Skills Motor Skills : 1. Measuring Skills

2. Connecting instruments / machines

List of Practical's:

- 1) a) To measure the slip of 3-phase IM by
 - i) Tachometer
 - ii) Comparing rotor & stator frequency
 - iii) Stroboscopic method.
- b) To reverse the direction of rotation of 3-phase IM.
- 2) To measure the performance of 3-phase IM by direct loading
- 3) To list different types of starters used for 3-phase IM .Identify & use the same to start & run 3-phase IM
- 4) Using an MG set (DC motor-Alternator) observe the effect of excitation & speed on induced e.m.f. & plot O.C.C. of the given alternator.
- 5) To find the percentage regulation of 3-phase alternator by synchronous impedance method at various power factors.
- 6) To find the percentage regulation of 3-phase alternator by direct loading method at various power factors.
- 7) To list & explain various starting methods of synchronous motor & applying one of them to start the synchronous motor. Plot V & inverted V curve of the same.
- 8) To list the various types of 1-phase IM, Collect the literature for them from Dealers / manufacturers of local places & compare on the following pts.
 - i) Method of starting ii) Cost iii) Performance iv) Starting torque etc.
 Prepare a report

| List of Laboratory Experiments : | |
|---|---|
| 1 | To measure the performance of 3-phase IM by direct loading |
| 2 | Using an MG set (DC motor-Alternator) observe the effect of excitation & speed on induced e.m.f. & plot O.C.C. of the given alternator. |
| 3 | To find the percentage regulation of 3-phase alternator by direct loading method at various power factors |
| 4 | To list the various types of 1-phase IM, Collect the literature for them from Dealers / manufacturers of local places & compare on the following pts. i) Method of starting ii) Cost iii) Performance iv) Starting torque etc. Prepare a report |
| 5 | To list & explain various starting methods of synchronous motor & applying one of them to start the synchronous motor. Plot V & inverted V curve of the same |
| 6 | To list different types of starters used for 3-phase IM .Identify & use the same to start & run 3-phase IM |

ELECTRIC TRACTION LAB -I (ELECTRICAL ENGINEERING GROUP)

| | | | | | | | |
|---------------------------------|--------------------------------|----------|------------|-------------------|----------|-----------|----------------|
| Subject Code 1620508 | Practical | | | | | | Credits |
| | No. of Periods Per Week | | | Full Marks | : | 50 | 01 |
| | L | T | P/S | ESE | : | 50 | |
| | — | — | 02 | Internal | : | 15 | |
| | — | — | — | External | : | 35 | |

CONTENTS: PRACTICAL**List of Experiments:-**

| | |
|---|---|
| 1 | <p>Drawing Sheets:</p> <p>(i) Drawing on half Imperial sheet for Traction Substation Layout or Feeding Post.</p> <p>(ii) Drawing of half Imperial sheet for Pentagonal OHE Catenary, Different Catenary. according to speed limit, Cantilever assembly OHE Supporting structure, Pentograph, Cross section of Contact Wire.</p> <p>Note: Students should be able to identify, explain the functions of various components of substation and OHE.</p> <p>Visits:</p> <p>Visit to Traction Substation (for substation layout and OHE) or Railway Station (for signaling and train lighting) and writing a report.</p> |
|---|---|

INDUSTRIAL AUTOMATION LAB (ELECTRICAL ENGINEERING GROUP)

| Subject Code 1620509 | Practical | | | | | | Credits |
|--------------------------------|-------------------------|---|-----|------------|---|----|---------|
| | No. of Periods Per Week | | | Full Marks | : | 50 | 01 |
| | L | T | P/S | ESE | : | 50 | |
| | — | — | 02 | Internal | : | 15 | |
| | — | — | — | External | : | 35 | |

CONTENTS: PRACTICAL

Intellectual Skills: a. Logical development
b. Programming skills

Motor Skills : a. Interpretation skills
b. Connecting properly

List of Practical's:

- 1) a) To plot the characteristics of potentiometer
b) Use of potentiometer as error detector
- 2) To plot V-I characteristics of DC & AC servomotors. compare them with DC & AC motor characteristics
- 3) a) To plot the characteristics of synchro transmitter
b) Use of synchro transmitter- control transformer pair as error detector.
- 4) Measure step angle for a stepper motor in forward & reverse direction.
- 5) Draw a power circuit & control circuit using control symbols for a 3-phase IM using DOL starter.
- 6) Observe various components /parts/symbols/connections of a PLC demonstration kit in your laboratory.
- 7) Draw a ladder logic diagram for two different examples.
- 8) By using above ladder logic diagram observe the status of I/Os using PLC.
- 9) Perform stepper motor/ temperature control using PLC.
- 10) Identify the parts of hydraulic/ pneumatic servomotor from cut-section/model.

B) Mini Project: (one in a group of eight students)

- 11) Collect the data of various PLC brands market & list.
- 12) Collect the data from internet about hardware & software of new control systems like SCADA, DCS.
- 13) Use the various control components in your laboratory to built a AC/DC position control system.
- 14) Built P, I, PI, PD & PID controller using op-amps & R-C circuits. Plot V-I characteristics

List of Laboratory Experiments :

| | |
|---|--|
| 1 | a) To plot the characteristics of potentiometer b) Use of potentiometer as error detector |
| 2 | To plot V-I characteristics of DC & AC servomotors. compare them with DC & AC motor characteristics |
| 3 | Observe various components /parts/symbols/connections of a PLC demonstration kit in your laboratory. |
| 4 | Collect the data from internet about hardware & software of new control systems like SCADA, DCS |
| 5 | Make a study of DC/AC position control system using Various control components. |

INDUSTRIAL PROJECT AND ENTREPRENEURSHIP DEVELOPMENT- TW (ELECTRICAL ENGINEERING GROUP)

| Subject Code 1620510 | Term Work | | | | | | Credits 01 |
|--------------------------------|-------------------------|---|-----|------------|---|----|----------------------|
| | No. of Periods Per Week | | | Full Marks | : | 25 | |
| | L | T | P/S | Internal | : | 07 | |
| | — | — | 04 | External | : | 18 | |

CONTENTS : TERM WORK

PART A) Industrial Project

Following activities related to project are required to be dealt with, during this semester

1. Form project batches & allot project guide to each batch. (Max. 4 students per batch)
2. Each project batch should select topic / problem / work by consulting the guide & / or industry. Topic / Problem / work should be approved by Head of department.
3. Each project batch should prepare action plan of project activities & submit the same to respective guide.
4. At the end of semester, each project batch should submit the action plan and abstract of the project along with list of materials required if project involves fabrication or other facilities required in other kinds of project.
5. Action Plan should be part of the project report.

Actual work of project should be done in sixth semester.

| Group | Projects |
|-------|---|
| 01 | (1) Design of Illumination Scheme (Up to 20 KW) for Hospital / Shopping Mall / Cinema Theatre / Commercial Complex / Educational Institute / Industrial Complex. (2) Design of Rural Electrification Scheme for small Village, Colony. (3) Case Studies Related to Industries – Operation / Maintenance / Repair and Fault Finding. (Refer Guideline Document). (4) Energy Conservation and Audit. (5) Substation Model (Scaled) (6) Wind Turbine Model (Scaled) (7) Pole Mounted Substation Model (Scaled) |
| 02 | (1) Rewinding of Three Phase/Single Phase Induction Motor. (2) Rewinding of Single Phase Transformer. (3) Fabrication of Inverter up to 1000 VA. (4) Fabrication of Battery Charger. (5) Fabrication of Small Wind Energy System for Battery Charging. (6) Fabrication of Solar Panel System for Battery Charging. (7) Microprocessor/ Micro controller Based Projects. (8) PC Based Projects. (9) Simulation Projects. |
| 03 | Seminar on any relevant latest technical topic based on latest research, recent trends, new methods and developments in the field of Electrical Engineering / Power Electronics. |

Part B: Entrepreneurship Development**Objectives:**

Students will be able to

- 1) Identify entrepreneurship opportunity.
- 2) Acquire entrepreneurial values and attitude.
- 3) Use the information to prepare project report for business venture.
- 4) Develop awareness about enterprise management.

| Chapter | Name of the Topic | Hours |
|----------------|---|-------|
| Unit-01 | <p>Entrepreneurship, Creativity & Opportunities</p> <p>1.1) Concept, Classification & Characteristics of Entrepreneur</p> <p>1.2) Creativity and Risk taking. 1.2.1) Concept of Creativity & Qualities of Creative person. 1.2.2) Risk Situation, Types of risk & risk takers.</p> <p>1.3) Business Reforms. 1.3.1) Process of Liberalization. 1.3.2) Reform Policies. 1.3.3) Impact of Liberalization. 1.3.4) Emerging high growth areas.</p> <p>1.4) Business Idea Methods and techniques to generate business idea.</p> <p>1.5) Transforming Ideas in to opportunities transformation involves Assessment of idea & Feasibility of opportunity</p> <p>1.6) SWOT Analysis</p> | 03 |
| Unit-02 | <p>Information And Support Systems</p> <p>2.1) Information Needed and Their Sources: Information related to project, Information related to support system, Information related to procedures and formalities</p> <p>2.2) Support Systems 1) Small Scale Business Planning, Requirements. 2) Govt. & Institutional Agencies, Formalities 3) Statutory Requirements and Agencies.</p> | 02 |
| Unit-03 | <p>Market Assessment</p> <p>3.1) Marketing -Concept and Importance 3.2) Market Identification, Survey Key components 3.3) Market Assessment</p> | 02 |
| Unit-04 | <p>Business Finance & Accounts Business Finance</p> <p>4.1) Cost of Project 1) Sources of Finance 2) Assessment of working capital 3) Product costing 4) Profitability 5) Break Even Analysis 6) Financial Ratios and Significance</p> <p>Business Account</p> <p>4.2) Accounting Principles, Methodology 1) Book Keeping 2) Financial Statements 3) Concept of Audit</p> | 03 |

| | | |
|----------------|--|-----------|
| Unit-05 | Business Plan & Project Report 5.1) Business plan steps involved from concept to commissioning Activity Recourses, Time, Cost 5.2) Project Report 1) Meaning and Importance 2) Components of project report/profile (Give list) 5.3) Project Appraisal 1) Meaning and definition 2) Technical, Economic feasibility 3) Cost benefit Analysis | 03 |
| Unit-06 | Enterprise Management And Modern Trends 6.1) Enterprise Management: 1) Essential roles of Entrepreneur in managing enterprise 2) Product Cycle: Concept and importance 3) Probable Causes Of Sickness 4) Quality Assurance: Importance of Quality, Importance of testing 6.2) E-Commerce: Concept and Process 6.3) Global Entrepreneur 6.3.1 Assess yourself-are you an entrepreneur? 6.3.2 Prepare project report and study its feasibility. | 03 |
| Total | | 16 |

| | | Text /Reference Books: | |
|--|--|---|--|
| Titles of the Book | Name of Authors | Name of the Publisher | |
| Entrepreneurship Theory and Practice | J.S. Saini B.S.Rathore | Wheeler Publisher | |
| TTTI, Bhopal / Chandigadh | -- | -- | |
| Entrepreneurship Development | E. Gorden K.Natrajan | Himalaya Publishing. | |
| Entrepreneurship Development | Prepared by Colombo plan staff college for Technician Education. | Tata Mc Graw Hill Publishing co. Ltd. New Delhi. | |
| A Manual on How to Prepare a Project Report | J.B.Patel D.G.Allampally | EDI STUDY MATERIAL Ahmadabad (Near Village Bhat , Via Ahmadabad Airport & Indira Bridge), P.O. Bhat 382428 , Gujrat,India P.H. (079) 3969163, 3969153 E-mail : ediindia@sancharnet.in / olpe@ediindia.org Website : http://www.ediindia.org | |
| A Manual on Business Opportunity Identification & Selection | J.B.Patel S.S.Modi | | |
| National Derectory of Entrepreneur Motivator & Resource Persons. | S.B.Sareen H. Anil Kumar | | |
| New Initiatives in Entrepreneurship Education & Training | Gautam Jain Debmuni Gupta | | |
| A Handbook of New Entrepreneurs | P.C.Jain | | |

2) Video Cassettes:

| No | Subject | Source |
|-----------|--|--|
| 1 | Five success Stories of First Generation Entrepreneurs | EDI STUDY MATERIAL Ahmadabad (Near Village Bhat , Via Ahmadabad Airport |

| | | |
|---|---|---|
| 2 | Assessing Entrepreneurial Competencies | & Indira Bridge), P.O. Bhat 382428 , Gujrat,India P.H. (079) 3969163, 3969153 E-mail : ediindia@sancharnet.in / olpe@ediindia.org Website : http://www.ediindia.org |
| 3 | Business Opportunity Selection and Guidance | |
| 4 | Planning for completion & Growth | |
| 5 | Problem solving-An Entrepreneur skill | |

Glossary: Industrial Terms

Terms related to finance, materials, purchase, sales and taxes.

Components of Project Report:

1. Project Summary (One page summary of entire project)
2. Introduction (Promoters, Market Scope/ requirement)
3. Project Concept & Product (Details of product)
4. Promoters (Details of all Promoters- Qualifications, Experience, Financial strength)
5. Manufacturing Process & Technology
6. Plant & Machinery Required
7. Location & Infrastructure required
8. Manpower (Skilled, unskilled)
9. Raw materials, Consumables & Utilities
10. Working Capital Requirement (Assumptions, requirements)
11. Market (Survey, Demand & Supply)
12. Cost of Project, Source of Finance
13. Projected Profitability & Break Even Analysis
14. Conclusion.

PROFESSIONAL PRACTICES – V - TW (ELECTRICAL ENGINEERING GROUP)

| | | | | | | | |
|---------------------------------|--------------------------------|----------|------------|-------------------|----------|-----------|-----------|
| Subject Code 1620511 | Term Work | | | Credits | | | |
| | No. of Periods Per Week | | | Full Marks | : | 25 | 01 |
| | L | T | P/S | Internal | : | 07 | |
| | — | — | 03 | External | : | 18 | |

CONTENTS: TERM WORK

| | Activity | Hours |
|---------------|---|-----------|
| Unit-1 | <p>Industrial Visits Structured industrial visits be arranged and report of the same should be submitted by the individual student, to form a part of the term work. Following are the suggested type of Industries/ Fields -</p> <ul style="list-style-type: none"> i) Visit to Electrical Machine Manufacturing Industry. ii) Visit to a Foundry to see Furnaces and Ovens. iii) Visit to L & T LT Switchgear Laboratory at Pune. iv) Visit to Railway Station to study operation of Signaling system. v) Visit to Loco shed or EMW at Nasik. vi) Visit to Large Industry to study Protection Schemes. vii) Any Industry having Automation for manufacturing Processes. | 16 |
| Unit-2 | <p>The Guest Lecture/s from field/industry experts, professionals to be arranged minimum 3 Lectures each of two hours from the following or alike topics. The brief report to be submitted on the guest lecture by each student as a part of Term work</p> <ul style="list-style-type: none"> a) Modern trends in A. C. Machines b) Bio Medical Instruments: Working, Calibration etc c) Testing of Switchgears d) Computer aided drafting. e) Automotive wiring & lighting. f) Environmental pollution & control. g) Interview Techniques. h) Automobile pollution, norms of pollution control. | 10 |
| Unit-3 | <p>Information Search (Student seminars based on information search & guest lecture topics.)</p> <ul style="list-style-type: none"> a) Magnetic Levitation Systems b) Recent developments in use of Electrically operated vehicles for mass transport c) Metro Railway in Kolkata and Delhi comparative study d) Electrically operated Motor Cars and Scooters/Motorbikes e) Alternative fuels & energy options. f) Any other topic | 06 |
| Unit-4 | <p>Group Discussion : The students should discuss in group of six to eight students and write a brief report on the same as a part of term work. The topic of group discussions may be selected by the faculty members. Some of the suggested topics are -</p> <ul style="list-style-type: none"> i) CNG versus LPG as a fuel. ii) Load shading and remedial measures. iii) Rain water harvesting. iv) Trends in energy conservation v) Disaster management. vi) Use of Plastic Carry Bags vii) Safety in day to day life. viii) Energy Saving in Institute. | 06 |
| Unit-5 | <p>Seminar : Seminar topic should be related to the subjects of fifth semester / topics from information search & guest lectures. Each student shall submit a report of at least 10 pages and deliver a seminar (Presentation time – 10 minutes)</p> | 10 |
| Total | | 48 |