PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of Electrical Engineering

SYLLABUS FOR 6th Sem BTech PROGRAMME

Power System-II (03106351)

Type of Course: BTech

Prerequisite: Basic knowledge of Electrical Power System

Rationale: On completion of this course, the students will be able to do the transient analysis of the power system and the modeling of power system components.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
3	0	2	4	60	30	20	20	20	150

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Performance of Transmission Line:**: The short transmission line, The medium-length line, The long transmission line: Solution of the differential equations, The long transmission line: Interpretation of the equations, The long transmission line: Hyperbolic form of the differential equations, The equivalent circuit of a long line, Power flow through a transmission line (circle diagrams), Reactive compensation of transmission lines, Skin Effect.	15%	7
2	**Symmetrical Three-Phase Faults:**: Transients in RL Series circuits, Short-Circuit currents and the reactance of Synchronous machines, Internal voltages of loaded machines under transient conditions, The bus impedance matrix in fault calculations, A bus impedance matrix equivalent network, The selection of circuit breakers.	15%	7
3	**Symmetrical Components:**: Synthesis of Unsymmetrical Phasor from their symmetrical components, Operators, The symmetrical components of unsymmetrical Phasor, Phase shift of symmetrical components in Star-Delta Transformer Banks, Power in terms of symmetrical components, Unsymmetrical Series impedances, Sequence Impedances and sequence networks, Sequence networks of Unloaded Generators, Sequence impedances of circuit elements, Positive and negative sequence networks, Zero sequence networks.	13%	6

4	**Unsymmetrical Faults:**: Single line to ground fault on an unloaded generator, Line to Line fault on an unloaded generator, Double Line to Ground fault on an unloaded generator, Unsymmetrical faults on power systems, Single line to Ground fault on a power system, Line to Line fault on a power system, Double Line to Ground fault on a power system, Interpretation of the interconnected sequence networks, Analysis of unsymmetrical faults using the bus impedance matrix, Faults through impedance, Computer calculations of fault currents.	18%	8
5	**Transients in Power Systems:**: Transients in Simple Circuits, 3-phase Sudden Short Circuit of an Alternator, The Restriking Voltage after Removal of Short Circuit, Travelling Waves on Transmission Lines, Attenuation of Travelling Waves, Overvoltage due to Arcing Ground.	12%	5
6	**Theory of Circuit Interruption :**: Physics of arc phenomena, Maintenance of arc, Essential properties of arc, Arc control devices, Losses from plasma, Circuit constants & circuit conditions, Interaction between breaker & circuit, Arc interruption theories, recovery and re-striking voltages, Characteristics of re-striking voltages, Current chopping, Interruption of capacitive current, Resistance switching.	9%	4
7	**Ratings of Circuit Breaker & Circuit Breakers:**: **Different ratings of circuit breakers:** Rated voltage, Continuous current rating, Rated frequency, Rated breaking capacity-symmetrical & unsymmetrical, Making capacity, Rated interrupting duties, Short time rating, MVA capacity. Circuit breaker operating mechanism, Rated operating sequence, **Working & Construction:** Bulk oil circuit breaker, MOCB, ACB, ABCB. Vacuum circuit breaker, Sulphur hexafluoride (SF6) circuit breakers, D.C. circuit breakers, Performance of circuit breaker & system requirements, Auto reclosure, Modification of circuit breaker duty by shunt resistors	18%	8

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. Power System Analysis (TextBook)
   Hadi Sadat; Tata McGraw Hill, New Delhi
2. Power Systems Analysis
   John J. Grainger and W. D. Stevenson; Tata McGrawHill International
3. A Course in Power Systems (TextBook)
   J.B. Gupta; Katson Publication
4. Principles of Power System
   V. K. Mehta Rohit Mehta; S. Chand
5. Electrical Power systems
   C. L .Wadhwa; New Age InternationalPublishers.; 5th
6. Modern Power System Analysis (TextBook)
   D P Kothari and I J Nagrath; Tata McGrawHill; 4

Course Outcome:

After Learning the course the students shall be able to:

1. Comparison Between Short, Medium and Long transmission Line and its Methods.
2. Understand the concept of Electrical Fault and its Classification.
3. To Understand Symmetrical component in different Types of unsymmetrical fault.
4. Analyze the transient behavior of the system
5. Understand Different types of Circuit Breaker and its Importance

List of Practical:

1. To write computer program for voltage regulation and efficiency of short transmission line.
2. To write computer program to calculate voltage regulation and efficiency of a Medium transmission line (using π model& T model)
3. To write computer program to calculate voltage regulation and efficiency of a Long transmission line using Hyperbolic Equations, Equivalent T model and Equivalent π model.
4. To write a computer program and for obtaining symmetrical components for a given set of unbalanced Phasor
5. To write program for transient in series R-L circuit with changes in DC offset current.
6. To model & write computer program for L-G fault of a small system using interconnection of sequence networks
7. To model & write computer program for L-L fault of a small system using interconnection of sequence networks.
8. To model & write computer program for DLG fault of a small system using interconnection of sequence networks.
9. A study of travelling waves of a long transmission line.
10. Analyze the Ferranti Effect of transmission line/cable in Virtual Lab.

PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of Electrical Engineering

SYLLABUS FOR 6th Sem BTech PROGRAMME

High Voltage Engineering (03106352)

Type of Course: BTech

Prerequisite: Knowledge of power system & electrical field theory.

Rationale: This subject deals with the detailed analysis of Breakdown occur in gaseous, liquids and solid Dielectrics. Information about generation and measurement of High voltage and current. In addition the High voltage testing methods are also discussed.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
3	0	2	4	60	30	20	20	20	150

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**INTRODUCTION TO HIGH VOLTAGE TECHNOLOGY AND APPLICATIONS**: Electric Field Stresses, Gas / Vaccum as Insulator, Liquid Dielectrics, Solids and Composites, Estimation and Control of Electric Stress, Numerical methods for electric field computation, Applications of insulating materials in transformers, rotating machines, circuit breakers, cable power capacitors and bushings	4%	2
2	**BREAK DOWN IN GASEOUS AND LIQUID DIELECTRICS**: Gases as insulating media, collision process, Ionization process, Townsend’s criteria of breakdown in gases, Paschen’s law. Liquid as Insulator, pure and commercial liquids, breakdown in pure and commercial liquids.	10%	5
3	**BREAK DOWN IN SOLID DIELECTRICS**: Intrinsic breakdown, electromechanical breakdown, thermal breakdown, breakdown of solid dielectrics in practice, Breakdown in composite dielectrics, solid dielectrics used in practice	4%	2
4	**GENERATION OF HIGH VOLTAGES AND CURRENTS**: Generation of High Direct Current Voltages, Generation of High alternating voltages, Generation of Impulse Voltages, Generation of Impulse currents, Tripping and control of impulse generators	17%	7

5	**MEASUREMENT OF HIGH VOLTAGES AND CURRENTS**: Measurement of High Direct Current voltages, Measurement of High Voltages alternating and impulse, Measurement of High Currents-direct, alternating and Impulse, Oscilloscope for impulse voltage and current measurements	8%	4
6	**OVER VOLTAGE PHENOMENON & INSULATION CO-ORDINATION**: Natural causes for over voltages – Lightning phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions, Principles of Insulation Coordination on High voltage and Extra High Voltage power systems	13%	6
7	**NON-DISTRUCTIVE TESTING OF MATERIAL AND ELECTRICAL APPARATUS**: Measurement of D.C Resistivity, Measurement of Dielectric Constant and loss factor, Partial discharge measurements	27%	11
8	**HIGH VOLTAGE TESTING OF ELECTRICAL APPARATUS**: Testing of Insulators and bushings, Testing of Isolators and circuit breakers, Testing of cables, Testing of Transformers, Testing of Surge Arresters, Radio Interference measurements	17%	8

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. High Voltage Engineering (TextBook)
   M.S. Naidu and V. Kamaraju; Tata McGraw Hill
2. High Voltage Engineering: Fundamentals byl by Elsevier, 2nd Edition.
   E. Kuffel, W. S. Zaengl, J. Kuffel; Elsevier; 2nd Edition, 2007
3. High Voltage Engineering-Theory and Practice
   M. Khalifa Marcel Dekker; Inc. New York and Basel; First, 1990
4. High Voltage Engineering
   C.L.Wadhwa; New Age Internationals (P) Limited; Third, 2010

Course Outcome:

After Learning the course the students shall be able to:

After learning the course the students shall be able to:
1 Design the insulation of HV power equipment.
2 Estimate electric field intensity of different electrode configurations.
3 Analysis the breakdown phenomenon of insulating materials used in electrical system.
4 Identifies evaluation through testing methodologies in high voltage engineering.
5 Demonstrates the different generation technique for high voltage measurement.
6 Demonstrates the different measurement technique for high voltage.

List of Practical:

1. Learning of High Voltage Laboratory Design and Safety measure.
2. Testing of Transformer Oil according to IS:6792.
3. Generation of high D.C. voltages and Measurement through sphere gaps.
4. Generation of high A.C. voltages and Measurement through sphere gaps.
5. Testing of Solid Insulation with Tape Electrodes.
6. To generate High AC voltages through cascaded Transformer.

7. Impulse Voltage Generation through Marx generator.
8. Impulse Voltage Generation through Simulation.
9. Trace the Field through electrolytic tank.
10. Capacitance and Loss factor measurement.
11. Stress Analysis of Transformer using FEMM.
12. Stress Analysis of single core single layer insulation using FEMM.
13. Stress Analysis of three core multi- layer insulation using FEMM.
14. Field distribution of Sphere gap geometry using FEMM.

PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of Electrical Engineering

SYLLABUS FOR 6th Sem BTech PROGRAMME

Transformer & DC Machine Design (03106353)

Type of Course: BTech

Prerequisite: Electrical Machine-I & II

Rationale: To give a good grounding and some experience in the physical design of electrical machines In addition, it will give a general idea on topics like mechanical, manufacturing and future challenges for machine design.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
3	1	0	4	60	30	20	20	20	150

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**GENERAL DESIGN ASPECTS:**: Specific Electrical loading, Specific magnetic loading and their selection for rotating electrical machines; Output coefficient & Output Equation for dc machines ; Factors affecting size of machines; Output Equation for single phase and three phase transformers; Modes of heat dissipation; Thermal state in electrical machines; Cooling of transformer and rotating machines.	13%	6
2	**Armature Windings:**: Introduction: Basic terms related to armature winding, open & closed winding, Single and Double layer winding. DC Armature Windings: Lap & Wave windings, Winding Pitches, Simplex Lap & Wave winding, Duplex lap & wave winding, Dummy Coils, Equalizer connections, Numericals.	13%	6

3	**DESIGN OF THREE PHASE TRANSFORMER:**: Classification of transformers; Core and Winding arrangement of single and three phase transformer; Position of winding relative to core; Core & Yoke cross section; Different types of transformer windings; Tapings and its importance; Window space factor & factors affecting window space factor; Relation between emf per turn and transformer rating; Stacking factor. Design of window dimensions, yoke dimensions and overall core dimensions; Numerical examples. <u>Winding Design</u> HV & LV Winding design: Turns per phase, cross-sectional area of conductor, selection of type of winding, axial length & depth of winding; Resistance and Leakage reactance calculation; Calculation of no load current, Losses and Temperature rise of transformer; Design of tank with tubes; Calculation of tank dimensions; Numerical examples. <u>Basic design aspects of Instrument Transformers</u>. Design principles of Current transformer, dry transformer and high frequency transformer	40%	18
4	**DESIGN OF DC MACHINES:**: Introduction; Output equation; MMF calculation; Selection of number of poles; Design of core length and armature diameter; Carter's fringing curves and its significance; Design of length of air gap; Numerical examples. <u>ARMATURE DESIGN:</u> Choice of armature winding; Armature conductor; Number of armature slots; Slot dimensions; Slot loading; Design of armature core; Numerical examples. <u>DESIGN OF FIELD SYSTEMS</u>**:** Pole design; Design of field winding of shunt, series and compound machines; Design of inter poles; Effects and minimization of armature reaction; Design of commutator and brushes; Numerical examples.	34%	15

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. A course in electrical machine Design
   A. K. Sawhney; Dhanpat Rai and Sons
2. Electrical Machine Design
   R. K. Agrawal; S.K. Kataria & Sons
3. Design of Electrical Machine
   V. N. Mittle; Standard Publishers Distributors
4. Design Data Handbook
   A. Shanmugasundarm, G Gangadharan, R. Palani; Wiley Eastern Ltd.

Course Outcome:

After Learning the course the students shall be able to:

After learning the course the students shall be able to:
1. Understand the basic design aspects of rotating machines.
2. Understand the basic design principles of transformer and dc machines.
3. Able to calculate the main dimensions for transformer and dc machines.
4. Perform overall basic design calculations for DC machines.
5. Perform basic design calculations for Transformer.
6. Solve the different design problems stationary machine (Three phase transformer).
7. Translate application demands to simple design specifications.

List of Tutorial:

1. Design problem of DC machine
2. Design problem of three phase transformer
3. Design problem of field system of DC machine

PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of Electrical Engineering

SYLLABUS FOR 6th Sem BTech PROGRAMME

Industrial Instrumentation (03106354)

Type of Course: BTech

Prerequisite: Basics Fundamentals of electrical engineering & Electrical Measurement

Rationale: The course provides the details knowledge different measuring apparatus

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
3	0	2	4	60	30	20	20	20	150

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Transducers:**: Introduction to instrumentation system, static and dynamic characteristics of an instrumentation system, Principles and classification of transducers, Electrical transducers, basic requirements of transducers, voltage sensors, current sensors, speed sensors, 4-20 ma loops.	8%	4
2	**Strain Gauge and Strain Measurement:**: Factors affecting strain measurements, Types of strain gauges, theory of operation of resistive strain gauge, gauge factor, types of electrical strain gauges, strain gauge materials, gauging techniques and other factors, strain gauge circuits and temperature compensation, applications of strain gauges.	12%	6
3	**Displacement Measurement:**: Resistive potentiometer (Linear, circular and helical), L.V.D.T., R.V.D.T. and their characteristics, variable inductance and capacitance transducers, Piezo electrical transducers-output equations and equivalent circuit, Hall effect devices and Proximity sensors, Large displacement measurement using synchros and resolvers, Shaft encoders.	12%	6
4	**Forces and Torque Measurement:**: Load cells and their applications, various methods for torque measurement. Use of torque wrenches	8%	3

5	**Pressure Measurement:**: Mechanical devices like Diaphragm, Bellows, and Bourdon tube for pressure measurement, Variable inductance and capacitance transducers, Piezo electric transducers, L.V.D.T. for measurement of pressure, Low pressure and vacuum pressure measurement using Pirani gauge, McLeod gauge, Ionization gauge, Pressure gauge calibration,	10%	4
6	**Flow Measurement:**: Differential pressure meter like Orifice plate, Venturi tube, flow nozzle, Pitot tube, Rotameter, Turbine flow meter, Electromagnetic flow meter, hot wire anemometer, Ultrasonic flow meter.	8%	4
7	**Level Measurement:**: Resistive, inductive and capacitive techniques for level measurement, Ultrasonic and radiation methods, Air purge system (Bubbler method).	8%	2
8	**Temperature Measurement:**: Resistance type temperature sensors – RTD & Thermister, Thermocouples & Thermopiles, Different types of Pyrometers. Humidity measurement and Moisture measurement techniques. infrared guns	10%	6
9	**Digital Data Acquisition systems & control :**: Use of signal conditioners, scanners, signal converters, recorders, display devices, A/D & D/A circuits in digital data acquisition. Instrumentation systems. Types of Instrumentation systems. Components of an analog Instrumentation Data – Acquisition system. Multiplexing systems. Uses of Data Acquisition systems. Use of Recorders in Digital systems. Digital Recording systems. Modern Digital Data Acquisition system. Analog Multiplexed operation, operation of sample Hold circuits.	24%	10

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. Industrial Instrumentation & Control (TextBook)
   S. K. Singh; TMH Publication
2. Electrical and Electronics Measurement and Instrumentation (TextBook)
   A. K. Shawney; Dhanpatrai & sons publications
3. Principles of Industrial Instrumentation
   D Patranabis; Mc Graw hill
4. Mechanical & Industrial Measurements
   R. K. Jain; Khanna publication
5. Instrumentation measurement and analysis
   Nakra Chaudhari; Mc Grawhill
6. Fundamental of Industrial Instrumentation
   Alok Barua; wiley India

Course Outcome:

After Learning the course the students shall be able to:

1.Recall knowledge of measurement.
2.Differentiate between different transducers used for analog and digital measurement in industrial applications.
3.Recognize the use of Different Instruments which are used in Real time Application in industry
4.Develop the functionality of various elements of Digital Data Acquisition systems & control
5.Recognize the use of Different Recorders which are used in Real time Application in industry
6.Understand the architecture of Analog and Digital System

List of Practical:

1. Introduction To Different Transducer & Their Characteristics In Detail
2. Perform the principle and working of a temperature controlling using Thermistor as a transducer.
3. Perform RTD As A Temperature Controlling Transducer. & Calibration of RTD
4. Perform Measurement of Temperature Using Thermocouple
5. Perform The characteristic of Strain Gauge
6. Perform The characteristic of Load Cell & Define its Application
7. Perform The characteristic of LVDT
8. Perform Flow measurement Using Venturi Tube
9. Perform Flow measurement Using Pitot Tube
10. Perform Pressure using Pressure Gauge Sensor
11. Perform Displacement Measurement using Piezo Electric Sensor
12. Study Measurement Using Inductive & capacitive transducer
13. To Study About Different Types of Digital Recorders
14. To Study About Data Acquisition systems & control
15. Hands on Virtual Lab (Sensor lab) Practical of Instrumentation

PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of Electrical Engineering

SYLLABUS FOR 6th Sem BTech PROGRAMME

Electrical Minor Project-III (03106355)

Type of Course: BTech

Prerequisite: Basic Electronics, Fundamentals of Signals & Systems, Electrical Machines-I, Network Analysis, Analog & Digital Electronics, Electrical Machines-II, Control System Engineering, Electromagnetic, Industrial Electronics-I, Power System-I, Microcontroller and its Application, Electrical Measurement, Industrial Electronics-II, Power Electronics Converter, Distributed Generation, Aurdino and PIC

Rationale: Project Title to be selected such that basic idea taken from the subject which can be experienced hands on.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
0	0	2	1	0	30	0	0	20	50

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Guidelines for Minor Project- III**: 1. The students must have to form a team consisting of maximum two members and they have to decide their team leader and their proposed work for the Minor Project-III. 2. Each student has to present two power point presentations for continuous evaluation during the semester. 3. The first presentation must be related to justification of their title of project. 4. The final presentation must be related to their circuit design work, software simulation and hardware implementation. 5. Students have to submit soft copy of power point presentation as well as hard copy of the report per team. 6. Presentation schedule will be declared by the department. 7. Guidelines for the Department and Supervisors: 8. Department has to depute supervisors to each team. The students will select the topics for Minor Project III according to their theoretical knowledge of fundamental subjects in electrical technology. 9. For the continuous evaluation of the Minor Project-III, total 20 marks are divided into two parts. 10. (a) 1st presentation---10 marks 11. (b) 2nd presentation---10 marks 12. The continuous evaluation will be based on their technical knowledge, oral and power point presentation skills. Evaluation will also base on the analysis of information gathered by student about the project. 13. The student must have to design their own circuit relevant to their project work. 14. The student will have to submit the hardware model to the department at the end of the semester. 15. The practical evaluation of 20 marks will be done by a panel consisting of 3 to 5 faculty members based on their circuit design and viva voce on hardware model	100%	2

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Course Outcome:

After Learning the course the students shall be able to:

1. Design circuits using theoretical knowledge of Fundamental subjects.
2. Proficiency in electrical technology hands on necessary for engineering practice.
3. Contribute to the collective planning and take responsibility for the outcome of a team project.

PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of Electrical Engineering

SYLLABUS FOR 6th Sem BTech PROGRAMME

Power Electronics Application In Power System (03106380)

Type of Course: BTech

Prerequisite: Knowledge of elements of power system and power electronics

Rationale: The course provides detail knowledge about power electronics application in power system.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
3	0	2	4	60	30	20	20	20	150

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Reactive-Power Control in Electrical Power Transmission Systems**: Concept of Reactive Power, Uncompensated Transmission Lines, Passive Compensations.	15%	6
2	**Principles of Conventional Reactive-Power Compensators**: Definition of Flexible ac Transmission Systems (FACTS) and advantages, Synchronous Condensers, The Saturated Reactor (SR), The Thyristor- Controlled Reactor (TCR), The Thyristor-Controlled Transformer (TCT), The Fixed Capacitor-Thyristor-Controlled Reactor (FC-TCR), Mechanically Switched Capacitor-Thyristor- Controlled Reactor (MSC-TCR), The Thyristor-Switched capacitor and Reactor, The Thyristor-Switched capacitor-Thyristor-Controlled Reactor (TSC-TCR), A Comparison of Different SVCs.	25%	12
3	**STATCOM**: Principle of Operation, The V-I Characteristic, Harmonic Performance, Steady-State Model, SSR Mitigation, A Study System, STATCOM Performance, Dynamic Compensation, A Multilevel VSC Based STATCOM, A Selective Harmonic-Elimination Modulation (SHEM) Technique, Capacitor-Voltage Control, STATCOM Performance	20%	9
4	**The Thyristor-Controlled Series Capacitor (TCSC)**: Series Compensation, The TCSC Controller, Operation of the TCSC, The TSSC, Analysis of the TCSC, Capability Characteristics, Harmonic Performance, Losses. Response of the TCSC, Modeling of the TCSC. The SSSC, The Principle of Operation, The Control System, Applications, Power-Flow Control, SSR Mitigation.	20%	9

5	**Combined Compensators (UPFC and IPFC)**: Introduction, Operating principle and characteristics of UPFC and IPFC, Control Structure of UPFC and IPFC, Comparison of UPFC to series converters, and phase angle regulators, Generalized and multi functional FACTS controllers.	20%	9

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. Thyristor-based FACTS controllers for Electrical Transmission Systems (TextBook)
   R. Mohan Mathur, R K Verma,; Wiley IEEE Press
2. Understanding FACTS
   N. G. Hingorani and L. Gyugyi; Standard Publishers
3. FACTS Controllers in Power Transmission & Distribution
   Padiyar K R; New Age International.
4. Reactive Power Control in Electric Systems
   T J E Miller, John Willey,

Course Outcome:

After Learning the course the students shall be able to:

1. Develop understanding of power electronics and its application in power system.
2. Understand the functioning of power electronics switches, their implementation in power system.
3. Understand the working of various compensators used in power system.

List of Practical:

1. Introduction to MATLAB programming and Simulink.
2. Simulation of Uncompensated Transmission line and Study of different types of FACTS devices.
3. Simulation of Series Compensated Transmission line
4. Simulation of Shunt Compensated Transmission line.
5. Simulation of TCR Compensated Transmission line.
6. Simulation of TSC Compensated Transmission line.
7. Simulation of SVC Compensated Transmission line.
8. Simulation of FC-TCR Compensated Transmission line.
9. Simulation of The Thyristor-Controlled Series Capacitor (TCSC) Compensated Transmission line.
10. Simulation of Static Synchronous Series Compensator (SSSC) Compensated Transmission line.
11. Study on Voltage control through SVC.
12. Study of UPFC Compensated Transmission line.
13. Study of IPFC Compensated Transmission line.
14. Simulation and Study of 6-Pulse Converter.
15. Simulation and Study of 12-Pulse Converter.

PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of Electrical Engineering

SYLLABUS FOR 6th Sem BTech PROGRAMME

Flexible AC Transmission System & HVDC (03106381)

Type of Course: BTech

Prerequisite: Power System Analysis and Fundamental knowledge of Power Electronics

Rationale: The Power system transmission network is now a day's heavily loaded and to enhance the existing active as well as reactive power transmission capacity of the line management and control of active and reactive power is necessary. The subject aims to develop thorough understanding of requirement of power management in power system by employing power electronics based reactive power compensation devices.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
3	0	2	4	60	30	20	20	20	150

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Reactive-Power Control in Electrical Power Transmission Systems**: Reactive Power, Uncompensated Transmission Lines, Compensation: Shunt Compensation, Series Compensation, Series-Shunt Compensation, Series-series Compensation and Effect of compensation on power-Transfer Capacity.	9%	4
2	**Principles of Conventional Reactive-Power Compensators**: Introduction, The Thyristor - Controlled Reactor (TCR), The Fixed Capacitor-Thyristor-Controlled Reactor (FC-TCR), The Thyristor - Switched capacitor (TSC), The Thyristor-Switched Capacitor-Thyristor-Controlled Reactor (TSC-TCR), A Comparison of Different SVCs.	18%	8
3	**Emerging FACTS Devices**: Operation and control of power through: STATCOM, Thyristor controlled series capacitor (TCSC), Static synchronous series compensator (SSSC), Unified Power Flow Controller (UPFC), Interline Power Flow Controller (IPFC).	22%	10
4	**HVDC Transmission and Convertor Topology**: Introduction, Equipment required for HVDC System, Comparison of AC and DC transmission, Insulated Gate Bipolar Transistor (IGBT), HVDC Converter Valve and Valve Assembly, HVDC–VSC Operation and Principles, Three Phase Six Pulse Converter using SCRs, Twelve Pulse Bridge Converters.	13%	6

5	**Control of HVDC converter and system**: Introduction, Mechanism of AC power Transmission, Principles of Control, Necessity of Control in case of DC link, Rectifier Control Compounding of Rectifier, Power Reversal in DC link, Voltage Dependent Current Order Limit - Characteristics of Converter, System Control Hierarchy and Basic Philosophy, Inverter Extinction Angle Control (EAC)	13%	6
6	**Converter Faults & Protection**: Introduction, Converter Faults, Protection against over currents, over voltages in a converter station, Surge arrester, protection against overvoltage.	12%	5
7	**Harmonics in HVDC Systems**: Introduction, Importance of Harmonic Study, Generation of Harmonics by Converters, Characteristics Harmonics on the DC Side, Characteristics Current Harmonics	13%	6

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. Thyristor-based FACTS controllers for Electrical Transmission Systems
   R. Mohan Mathur, R K Verma,; Wiley IEEE Press
2. Understanding FACTS
   N. G. Hingorani and L. Gyugyi; Standard Publishers
3. HVDC Transmission
   KAMAKSHAIAH,; Tata MC Graw Hill Education Pvt Ltd
4. Reactive Power Control in Electric Systems
   T J E Miller, John Willey,
5. FACTS Controllers in Power Transmission & Distribution
   Padiyar K R; New Age International.
6. Introduction to FACTS Controllers, Theory, Modeling and Applications
   Kalyan K. Sen, Mey Ling Sen; IEEE Press, John Wiley & Sons, New Jercy.

Course Outcome:

After Learning the course the students shall be able to:

1. Analyze reactive power requirement and management.
2. Assess and evaluate various compensators.
3. Simulate and design compensators.
4. Analyze various control schemes for various FACTS Controllers.

List of Practical:

1. Introduction to MATLAB programming and Simulink.
2. Simulation of Uncompensated Transmission line.
3. Study of different types of FACTS devices.
4. Simulation of Series Compensated Transmission line.
5. Simulation of Shunt Compensated Transmission line.
6. Simulation of TCR Compensated Transmission line.
7. Simulation of TSC Compensated Transmission line.
8. Simulation of FC-TCR Compensated Transmission line.
9. HVDC projects in INDIA.

10. Study of HVDC transmission and converters
11. Simulation and Study of 6-Pulse Converter.
12. Simulation and Study of 12-Pulse Converter.
13. Study of Protection equipments used in HVDC.
14. Harmonics analysis in HVDC systems.

PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of Electrical Engineering

SYLLABUS FOR 6th Sem BTech PROGRAMME

Industrial Automation (03106382)

Type of Course: BTech

Prerequisite: Knowledge of Basic Electronics, Microcontroller, Industrial Instrumentation and Power Electronics.

Rationale: In present global scenario of manufacturing, industries are moving towards more and moreautomation. Small scale and medium scale industries require PLC, HMI and SCADA technology, but large scale and very large scale industries require PLC, HMI and SCADA. So, it is very necessary for Electrical engineers to have knowledge of PLC, HMI and SCADA. So this course attempts to provide basic configurationally knowledge of these technologies to develop operational competency. Hence this course is very important for Electrical engineers who want to specialize in industrial automation.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
3	0	2	4	60	30	20	20	20	150

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Programmable Logic Controller**: **Programmable Logic Controller:**An overview of PLC, History of PLC, Advantages and Disadvantages of PLC, Internal Architecture, PLC Components, PLC System. **Input–Output Devices:** **Input-Output Processing:**Input and Output moduleinterfacing, Signal Conditioning, Remote Connections, Networks, PLC operation, Scan cycle, Scan time, Scan rate. **Ladder Programming:** General Programming Procedure, Ladder Diagram, Block Functions, Instruction list, Sequential Function Chart, Structured Text, Rules of ladder diagram, Construction of ladder diagram, Programming ON/OFF inputs to produce ON/OFF outputs, Logic Functions and Relation of digital gate logic to contact / coil logic, Creating ladder diagrams from process control descriptions, Basics of register. **PLC Functions:**Timer function, Counter function, Arithmetic function, Number comparison functions, Numbering systems and number conversion function, Skip and Master control relay functions, Jump functions, PLC data move systems, Digital bit functions and applications, Sequencer function, Analog PLC operations. **Applications of PLCs:** Stepper motor control, Speed control of D.C. motor & Induction motor, Lift/Elevator control, Water level control, Traffic control, Temperature control.	49%	22

2	**HMI In Automation**: **Automation system structure:**Basic structure of Automation system. **Instrumentation subsystem: C**ontrolcommands for Instrumentation subsystem, Various types of devices connected to Instrumentation subsystem. **Control subsystem:**Performance of control subsystem, Interface mechanism to interface control subsystem with other subsystems, Interfacing of control subsystem with human interface subsystem with example. **Human Interface subsystem:** Operator Panel, Active display elements and active control elements of operator panel, Construction of the panel, Interfacing with control subsystem, Types of mimic panels, Interfacing of mimic panel with control subsystem.	22%	10
3	**SCADA in Automation**: **Introduction to SCADA:**Definition of SCADA, History of SCADA, Application area of SCADA, Architecture and major elements of SCADA, Advantages and disadvantages of SCADA, Comparison of SCADA, PLC and Smart Instrumentation. **Real Time Systems and SCADA Software:** Definition and Introduction of real time control, Real time control for Continuous process, CommunicationAccess and Master-Slave concept, Determination of ScanInterval, SCADA software components, Concept of FBD technique, Comparison of centralized and distributed processing, HDLC Protocol. **SCADA Hardware: Remote Terminal Unit:**Structure of RTU, CPU, AnalogI/O, Pulse I/P, Digital I/Os, Communication Interface, Power supply, RTU Rack and Enclosure, Test and maintenance of RTU, Requirements for RTU System, ANSI/IEEE C37.1Protocol.	29%	13

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. Programmable Logic Controllers by (TextBook)
   John w. Webb and Ronald A. Reis; PHI
2. Practical SCADA for Industry by (TextBook)
   David Bailey, Edwin Wright, Newnes; Elsevier, 2003
3. Programmable Logic Controllers by
   John R. Hackworth, Frederick D. Hackworth; PearsonEducation Inc
4. Programmable Logic Controllers by
   W. Bolton; Newness (an imprint of Elsevier); 5th
5. Computer based Industrial Control by
   Krishnakant; PHI, New Delhi; 5th Edition or latest
6. SCADA-Supervisory Control and Data Acquisition System by
   Stuart A. Boyer; ISA publication
7. Overview of Industrial Process Automation by
   KLS Sharma; Elsevier Publication

Course Outcome:

After Learning the course the students shall be able to:

Understand the architecture of PLC.
Identify and programme the different functions of available PLC.
Design and programme the Industrial control systems using available PLC.
Identify and interpret PI diagram on HMI.
Identify and interpret different elements of SCADA.
Develop the functionality of various elements of SCADA.
Simulate the different control systems using SCADA
Design the hardware and control the different systems using available PLC and SCADA.

List of Practical:

1. Program based on ON/OFF input and ON/OFF output.
2. Program based on Timer functions.
3. Program based on Counter functions.
4. Program based on arithmetic and compare functions.
5. Program based on process control.
6. Program based on analog PLC Operation.
7. Simulate Traffic Light Control in PLC system.
8. Simulate bottle filling system using available PLC system.
9. Simulate mixing process in the tank using available PLC system.
10. Develop SCADA mimic diagram for tank level control.
11. Develop SCADA mimic diagram for tank temperature control.
12. Simulate level control system using available SCADA system.
13. Simulate Temperature control system using available SCADAsystem.
14. Control the tank level using available PLC and SCADA system. Use On/Off control action.
15. Control temperature and pressure of the process tank usingavailable PLC and SCADA system.