BHAGWANT UNIVERSITY
M.TECH IN POWER SYSTEM
(REGULAR)

I SEMESTER

SUBJECT CODE	NAME OF SUBJECT	HOURS/WEEK			CREDIT POINTS
		L	T	P	
01MPS101	Power system analysis	3	2	0	5
01MPS102	Advanced Power Electronics	3	2	0	5
01MPS103	Power System Stability	3	2	0	5
01MPS104	Power generation sources	3	2	0	5
01MPS201	MATLAB Programming Lab	0	0	5	3
01MPS301	Discipline & Co Curricular activities	0	0	4	1
total		12	8	4	24

II SEMESTER

SUBJECT CODE	NAME OF SUBJECT	HOURS/WEEK			CREDIT POINTS
		L	T	P	
02MPS101	Electric Drives & Their Control	3	2	0	5
02MPS102	Advanced Power System Protection	3	2	0	5
02MPS103	EHV AC/DC Transmission	3	2	0	5
02MPS104	Operation & control of power system	3	2	0	5
02MPS201	Power system Modeling & Simulation Lab	0	0	5	3
02MPS301	Discipline & Extra Curricular activities	0	0	4	1
	Total	12	8	4	24

III SEMESTER

SUBJECT CODE	NAME OF SUBJECT	HOURS/WEEK			CREDIT POINTS
		L	T	P	
03MPS101	Flexible ac transmission system	3	2	0	5
03MPS102	Excitation of synchronous machine & their control	3	2	0	5
03MPS201	Seminar	5		0	5
03MPS202	Dissertation stage-1	5	0	0	5
03MPS301	Discipline & Co Curricular activities	0	0	4	1
TOTAL		16	4	1	21

IV SEMESTER

SUBJECT CODE	NAME OF SUBJECT	HOURS/WEEK			CREDIT POINTS
		L	T	P	
04MPS201	DISSERTATION-2 a) Continuous Evaluation b) Project Report c) Viva Voice	5 5 6	0	0	5 5 6
04MDC301	Discipline & Co Curricular activities	0	0	4	1
TOTAL		16	0	1	17

M. TECH. I-SEMESTER

01MPS101 POWER SYSTEM ANALYSIS

Fault Analysis: Positive, Negative and Zero sequence equivalent circuits of lines, two and three winding transformers and synchronous machines. Analysis of shunt and series faults, effect of neutral grounding.

Admittance and Impedance Model and Network Calculations: Calculation of Z-bus, Y-bus.

Algorithm for the formation of bus admittances and impedance matrices, Fault calculation using Z-bus.
Load Flow Studies: Formulation of load flow problem. Various types of buses. Gauss-Siedel, Newton-Raphson and Fast Decoupled Algorithms.
Calculation of reactive power at voltage controlled buses in the Gauss-Siedel interactive method using Y-bus. Representation of transformers-Fixed tap setting transformer, Tap changing under load transformers, Phase shifting transformers, Comparison of methods for load flow.
Power System Security and State Estimation: Concepts of security states and security analysis in power system, State estimation in power system.

01MPS102 ADVANCED POWER ELECTRONICS

Phase Controlled Converters:
Performance measures of single and three-phase converters
with discontinuous load current for R, RL and RLE loads. Effect of source inductance for single and three-phase converters.
Chopper-
Review of choppers configurations, Steady state analysis of type A Chopper-
Minimum and Maximum Currents, Ripple and average load current. Commutation in Chopper Circuits.
Inverters:
Performance parameters, voltage control of three phase inverters-Sinusoidal PWM,
Third Harmonic PWM, 60 degree PWM and Space Vector Modulation. Harmonic reductions
AC Voltage Controllers:
Single and Three Phase AC Controllers. AC Voltage Controller
with PWM Control.
Cyclo-converters:
Single phase and three phase Cyclo-converters. Reduction in Output
Harmonics. Matrix Converter

01MPS103 POWER SYSTEM STABILITY

Synchronous Machines:
Modeling of cylindrical rotor synchronous machine, flux linkage
equations, voltage equations and equivalent circuit, real and reactive power control. Modeling of salient pole synchronous machine (Two – axis model), flux linkage equations, Park's transformation, current and voltage equations.
Transient and sub transient effects, reactance's and time constants of synchronous machines.
Equivalent circuits, vector diagrams, power angle equations and characteristics under steady state and transient conditions.
Steady State and Dynamic Stabilities:
Development of swing equation, linearization of
swing equation. Steady state stability of single machine connected to an infinite bus system and two machine systems. Coherent and non-coherent machines. Swing equation including damping effect. Introduction to dynamic stability of power system. Introduction to classical model of multi machine system.
Transient
Stability:
Equal area criterion and its application to transient stability studies under
common disturbances including short circuits. Critical clearing angle and critical clearing time. Numerical solution of swing equation by step-by-step method.
(i) Multi machine Transient Stability:
Numerical methods for solution of differential
equations: Modified Euler Method, Runge – Kutta fourth order method. Multi machine transient stability studies using modified Euler method and Range – kutta fourth order method.

(ii)Factors affecting steady state and transient stabilities. Methods of improving steady state, dynamic and transient stabilities, series capacitor compensation of lines, excitation control, power stabilizing signals, High speed circuit breaker, auto – recolsing circuits breaker, single pole and selective pole operation, by pass valving and Dynamic braking.

01MPS104 POWER GENERATION SOURCES

World energy situation. Indian energy scene. Comparative study of thermal, hydro, nuclear and gas power plants. Selection and location of power plants. Impact of thermal, gas, hydro and nuclear power stations on environment, air and water pollution, green house effect (global warming), impact on land. Renewable and non-renewable energy sources. Conservation of natural resources and sustainable energy sources.

Efficiency improvement of thermal and gas power plants-
pressurized fluid bed
combustion of coal, combined gas steam plant and cogeneration.

Solar Energy:
Solar radiation, solar radiation geometry, solar radiation on tilted surface.
Solar energy collector. Flat- plate collector, concentrating collector – parabolidal and heliostat. Solar pond. Basic solar power plant. Solar cell, solar cell array, basic photovoltaic power generating system.

(i) Wind Energy:
Basic principle of wind energy conversion, efficiency of conversion, site
selection. Electric power generation-basic components, horizontal axis and vertical axis wind turbines, towers, generators, control and monitoring component
ts. Basic electric generation schemes- constant speed constant frequency, variable speed constant frequency and variable speed variable frequency schemes. Applications of wind energy.

(ii) Geothermal Energy:
Geothermal fields, estimates of geothermal power. Basic geothermal
steam power plant, binary fluid geothermal power plant and geothermal preheat hybrid power plant. Advantages and disadvantages of geothermal energy. Applications of geothermal energy. Geothermal energy in India.

Nuclear Fusion Energy:
Introduction, nuclear fission and nuclear fusion. Requirements for
nuclear fusion. Plasma confinement - magnetic confinement and inertial confinement. Basic Tokamak reactor, laser fusion reactor. Advantages of nuclear fusion. Fusion hybrid and cold fusion.

Biomass Energy:
Introduction, biomass categories, bio-fuels. Introduction to biomass
conversion technologies. Biogas generation, basic biogas plants-fixed dome type, floating gasholder type, Deen Bandhu biogas plant, Pragati design biogas plant. Utilization of biogas. Energy plantation. Pyrolysis scheme. Alternative liquid fuels –ethanol and methanol. Ethanol production.

01MPS201 MATLAB PROGRAMMING LAB

1 Basics of MATLAB matrices and vectors, matrix and array operations, Saving and loading data, plotting simple graphs, scripts and functions, Script files, Function files, Global Variables, Loops, Branches, Control flow, Advanced data objects, Multi-dimensional matrices, Structures, Applications in linear algebra curve fitting and interpolation. Numerical integration, Ordinary differential equation. (All contents is to be covered with tutorial sheets)

2 Simulink:

Idea about simulink, problems based on simulink. (All contents is to be covered with tutorial sheets)

M. TECH. II- SEMESTER

02MPS101 ELECTRIC DRIVES & THEIR CONTROL

Characteristics of Electric Motors:

Characteristics of DC motors, 3-Phase induction motors and synchronous motors, Starting and braking of electric motors.

Dynamics of Electric

Drives:

Mechanical system, Fundamental torque equations, components of load torque's, Dynamic conditions of a drive system, Energy loss in transient operations, Steady State Stability, Load equalization.

DC Motor Drives:

Starting, Braking and Speed Control, Transient analysis of separately excited motor with armature and field control, Energy losses during transient operation, Phase controlled converter fed DC drives, Dual-converter control of DC drive, Supply harmonics, Power factor and ripple in motor current, Chopper Control DC drives, Source current harmonic in Choppers.

Induction Motor Drives:

Starting, Braking and transient analysis, Calculation of energy losses, Speed control, Stator voltage control, Variable frequency control from voltage and current sources, Slip power recovery-Static Scherbius and Cramer drives.

Synchronous Motor Drives:

Starting, Pull in and braking of synchronous motors, Speed control – variable frequency control, Cycloconverters control. Brushless DC Motor, Linear Induction Motor, Stepper Motor and Switched Reduction Motor Drives: Important features and applications.

Energy Conservation in Electrical Drives:

Losses in electrical drive system, Measures for energy conservation in electric drives, Use of efficient motor, Energy efficient operation of drives, Improvement of power factor and quality of supply.

02MPS102 ADVANCED POWER SYSTEM PROTECTION

(i) Static Relays:

Introduction, merits and demerits of static relays.

Comparators:

amplitude and phase comparator, duality between amplitude and phase comparators. Circulating current type phase-splitting type and sampling type amplitude comparators. Vector product type and coincidence type phase Comparators.

(ii) CTs & PTs:

Current transformer (CT) Construction,

measurement CT and protective CT. Type of potential transformers. Steady state ratio and phase angle errors in CTs and PTs. Transient errors in CT and CVT.

(i) Static Over Current Relays:

Instantaneous over current relay, definite time over current relay, inverse-time over current relay, directional over current relay.

(ii) Static Differential Relays:

Differential relay scheme, single-phase static comparator, polyphase differential protection. Differential protection for generator and transformer.

(i**) Static Distance Relays**:

Impedance relay, reactance relay and mho relay using amplitude and phase comparators. Polarized and offset mho relays.

(ii) Carrier Current Protection:

Phase Comparison scheme, carrier aided distance protection.

(i) Distance Protection:

Effect of are resistance, power swings, line length and source impedance on the performance of distance protection. Out of step tripping and blocking relays. Mho relay with blinders. Quadrilateral and elliptical relays. Selection of distance relays.

(ii) Induction Motor Protection:

Various faults and abnormal operating conditions.

Protection against faults, unbalance supply voltage, single phasing, over load and mechanical rotor faults, HRC fuses, over-current, percentage differential and earth fault protection. Negative sequence voltage relays and resistance temperature detector relay.

Digital Protection:

Introduction to digital protection, block diagram of digital relay, sampling theorem, correlation with a reference wave, Fourier analysis of analogue and discrete signals, least error squared technique, digital filtering – low pass, high pass, finite impulse response and infinite impulse response fillers. Introduction to digital over-current, transformer differential and transmission line distance protection.

02MPS103 EHV AC/DC TRANSMISSION

Bulk power transmission over long distance, Need for EHV transmission, Problem of EHV transmission power handing capacity and surge impedance loading, Current carrying capacity of conductor, Choice of economic voltage.

Bundled Conductors:

Properties of bundled conductors, Geometric mean radius of bundle, Inductance and capacitance, Voltage gradients of conductors, Maximum surface voltage gradients of bundled conductors, Comparison of maximum surface electric fields for bundled and single conductor lines, Electrostatic fields of EHV lines. Effect of ES fields of humans, Animals and plants.

Series and Shunt Compensation:

Effect of series capacitors, Location of series capacitors.

Sub-synchronous resonance in series-capacitor compensated lines and counter measures, Shunt compensation-variation of no load receiving end voltage. Static VAR systems: TCR, TCR-FC, TSC-TCR and MSC-TCR schemes

HVDC Transmission:

HVDC transmission, kind of dc links, light activated thyristor, series and parallel connection of thyristors. Scheme of converter station, 12 – pulse convecter, converter unit, converter operation, fitters, reactive power source, ground return and ground electrode.

HVDC Link:

Control of HVDC link, Converter control characteristics, firing angle control and extinction angle control. Comparison between AC and DC transmissions Applications of HVDC transmission. Power modulation and power control of HVDC lines.

02MPS104 OPERATION & CONTROL OF POWER SYSTEMS

Optimal Power System Operation:
System constraints. Generator operating cost. Input-
Output and incremental fuel characteristics of a generating unit. Optimal operation of generators on a bus bar, algorithm and flow chart. Optimal unit commitment, constraints in unit commitment, spinning reserve, thermal and hydro constraints.
Unit Commitment Solution Methods:
Priority list method and dynamic programming
method. Reliability consideration, Patton's security function, security constrained optional unit commitment, start- up considerations.
Optimal Generation Scheduling:
Development of transmission loss and incremental loss
equations. Optimal generation scheduling including transmission losses, algorithm and flow chart. Optimal load flow solution. Hydrothermal coordination.
Load Frequency Control:
Control of real and reactive power of generator. Turbine speed
governing system, Modelling of speed governing system. Methods of frequency control: flat frequency, flat tie line and tie line load bias control. Block diagram representation of load frequency control of an isolated system, steady state analysis, dynamic response. Introduction to Two – area load frequency control.
(i) Power System Security
: Introduction to power system security, System monitoring,
contingency analysis, System state classification, security control.
(ii) Automatic Generation Control:
Speed governing characteristic of a generating unit. Load
sharing between parallel operating generators. Introduction to automatic generation control of an area by computer (description of block diagram).

02MPS201 POWER SYSTEM MODELLING & SIMULATION LAB

1 Simulate Swing Equation in Simulink (MATLAB)
2 Modelling of Synchronous Machine.
3 Modelling of Induction Machine.
4 Simulate simple circuits using Circuit Maker.
5 (a) Modelling of Synchronous Machine with PSS (b) Simulation of Synchronous Machine with FACTS device.
6 (a) Modelling of Synchronous Machine with FACTS device (b) Simulation of Synchronous Machine with FACTS devices.
7 FACTS Controller designs with FACT devices for SMIB system.

03MPS101 FLEXIBLE AC TRANSMISSION SYSTEMS

Problems of AC transmission systems, power flow in parallel paths and meshed system, factors limiting loading capability, stability consideration. Power flow control of an ac transmission line. Basic types of facts controllers. Advantages of FACTS technology.
(i) Voltage-Sourced Converters:
Basic concept of voltage-sourced converters, single and
three phase bridge converters. Introduction to power factor control. Transformer connections for 12- pulse, 24 pulse and 48 pulse operations.
(ii) Static Shunt Compensators:
Mid point
and end point voltage regulation of transmission line, and stability improvement. Basic operating principle of Static Synchronous Compensators (STATCOM). Comparison between STATCOM and SVC.

Static Series Compensators:
Concept of series capacitive compensation, voltage and
transient stabilities, power oscillation and subsynehronous oscillation damping. Introduction to thyristor- switched series capacitor (TSSC), thyristor controlled series capacitor (TCSC), and static synchronous series compensator-operation, characteristics and applications.
(i) Static Voltage and Phase Angle Regulators:
Voltage and phase angle regulation. Power
flow control and improvement of stability by phase angle regulator. Introduction to thyristor controlled voltage and phase angle regulators (TCVR and TCPAR)
(ii)
Introduction to thyristor controlled braking resistor and thyristor controlled voltage limiter.
(i) UPFC:
Unified Power Flow Controller (UPFC), basic operating principles, conventional
transmission control capabilities. Comparison of UPFC to series compensators and phase angle regulator. Applications of UPFC.
(ii) IPFC:
Interline Power Flow Controller (IPFC), basic
operating principles and characteristics. Applications of IPFC.

03MPS102 EXCITATION OF SYNCHRONOUS MACHINES & THEIR CONTROL
Excitation Systems:
Real and reactive power control of a generating unit, loading capability
diagram, reactive capability limits. Excitation system requirements, elements of an excitation system, types of excitation systems.
i) DC Excitation System:
Configuration of a DC excitation system with main and pilot
exciters, automatic voltage regulator with magnetic amplifier and amplidyne. Limitations and problems of DC excitation systems.
(ii) AC Shunt Excitation Systems:
AC shunt excitation
system with static thyristor converter, effect of faults on performance, use of booster (current) transformer. Advantages, problem and application of AC shunt excitation systems.
(i) AC Separately Excitation Systems:
Configurations of AC separately excitation system
with (a) diode rectifier and (b) thyristor converter. Comparison and application of these schemes.
(ii) Brushless Excitation System:
Brush–slip ring problem. Scheme of brushless
excitation system with rotating diode. Control protection, monitoring and application of brushless excitation systems.
(i)
Introduction to super conducting synchronous generator.
(ii)
Dynamic Performance
Measures:
Introduction, large signal and small signal performance measures.
(iii) Control
and Protective Functions:
Basic excitation system control and protective circuit, AC and DC
regulator, power system stabilizer (PSS) and stabilizing circuit, load compensations, limiters and protection.
(i) Modelling of Excitation Systems:
Per unit system for exciter. Introduction to modelling of
DC and AC Exciters.

(ii)
Effect of excitation control on steady state, dynamic and transient stabilities.

SEMINAR

Course/Paper: 03MPS-201
MPS Semester-III

OBJECTIVE

The students are to select one technical topic related its branch for Seminar. The student is to submit the synopsis for assessment and approval. Progress for preparation of the seminar topic would be continuously assessed from time to time. Two periods per week are to be allotted and students are expected to present the seminar Progress. A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain the attendance.

Students have to give a final presentation for 15 minutes on his topic. Students are encouraged to use various teaching aids such as over head projectors, power point presentation and demonstrative models. This will enable them to gain confidence in facing the placement interviews

PROJECT

Course/Paper: 03MPS-202
MPS Semester-III

OBJECTIVE

The objective of the project work is to enable the students in convenient groups of not more than 3 members on a project involving theoretical and experimental studies related to the branch of study. Every project work shall have a guide who is the member of the faculty of the institution.
The student should select any one of the topics offered from the department or select one on his own duly approved from the department. Candidate is required to submit the detailed synopsis of the work that he would complete in the part-II

Each student shall finally produce a comprehensive report covering back ground information, literature survey, problem statement, project work details and conclusion. This final report shall be typewritten form as specified in the guidelines.

Semester IV

DISSERTATION

Course/Paper: 04MPS-201
MPS Semester-IV

The student will submit a synopsis at the beginning of the semester for the approval from the University project committee in a specified format. Synopsis must be submitted within a two weeks. The first defense, for the dissertation work, should be held with in a one month. Dissertation Report must be submitted in a specified format to the University for evaluation purpose.