RASHTRASANT TUKDOJIMAHARAJ NAGPUR UNIVERSITY

NAGPUR

M. Tech. Programme

in

POWER ELECTRONICS AND POWER SYSTEMS (PEPS)

(Syllabus Approved by RTMNU in 2010-11)

INTRODUCTION

It is proposed to start the new course "Power Electronics and Power systems" at post graduate level in the Department of ELECTRICAL ENGINEERING SRKNEC Nagpur. Presently it is offering one under graduate course in Integrated Electrical Engineering and Nagpur university and VNIT is offering M.Tech. in Integrated Power System. The under graduate course is offered since last 25 years and having intake capacity of 60 students per year. The RTMNU syllabi contain more of power system subjects. Now the overall growth and developments in the field of Electrical Power system has changed the many the basic contents and ideas to improve overall power conversion and utilization process. These new areas are recognized with the new subjects. They find it difficult to accommodate them in the same structure. The major change in the power in the power sectors and industries has come due to the Power Electronics and Power utilization also has many changed due to newer application requirements. These areas are having higher level of learning structure and require separate identity. Therefore it would emerge as a new course and is offered as a new course having combination of Power Electronics, Drives and Power systems. In our department, presently many faculties are having expertise in the field of Power system. There are also laboratories which are related to these subjects. Now department would soon be recognized as a research center by the Rashtra Sant Nagpur University Nagpur.

It is therefore proposed to start this course with the relevant subjects in the field of **Power Electronics and Power Systems**. The detail syllabus and scheme is also enclosed. The infrastructural requirements are also indicated in the enclosure with peripheral requirements. The required staff and supporting staff requirements are given for this course to run.

SCHEME OF EXAMINATION FOR M. TECH.(PEPS)

(POWER ELECTRONICS AND POWER SYSTEMS)

First Semester

Sub	Name of subject	Teaching scheme				Assessment of Marks for Theory				Assessment of Marks for Practical				Duration of Paper
		L	T	P/D	To	Paper	CA	Total	Min. for Passing	Univ. Exam	CA	Total	Min. Pass	
IFPEPS01	**Advanced Power Electronics**	3	1	2	6	70	30	100	50	25	25	50	25	3 Hrs
IFPEPS02	**Electric Power Distribution System**	3	1	-	4	70	30	100	50	-	-	-	-	3Hrs
IFPEPS03	**HVDC Power Transmission**	3	1	-	4	70	30	100	50	-	-	-	-	3Hrs
IFPEPS04	**Power System Modeling**	3	1		4	70	30	100	50	-	-	-	-	3Hrs
IFPEPS05	**Processor applications to Electrical /Power system**	3	1	2	6	70	30	100	50	25	25	50	25	3Hrs
	Total	15	5	4	24	350	150	**500**	-	-	50	**100**	-	**Total T+P =600**

Second Semester

Sub	Name of subject	Teaching scheme				Assessment of Marks for Theory				Assessment of Marks for Practical				Duration of Paper
		L	T	P/D	To	Paper	CA	Total	Min. for Passing	Univ. Exam	CA	Total	Min. Pass	
IIFPEPS01	**Advanced Power Electronic Drives**	3	1	2	6	70	30	100	50	25	25	50	25	3 Hrs
IIFPEPS02	**Advanced Control Theory**	3	1	-	4	70	30	100	50	-	-	-	-	3 Hrs
IIFPEPS03	**Elective 1**	3	1	-	4	70	30	100	50	-	-	-	-	3Hrs
IIFPEPS04	**Energy Management System**	3	1	2	6	70	30	100	50	-	-	-	-	3Hrs
IIFPEPS05	**Power Electronics applications to Power Systems**	3	1	-	4	70	30	100	50	-	-	-	-	3Hrs
IIFPEPS06	**Power system Simulation Lab**	-	-	2	2	-	-	-	-	25	25	50	50	-
	Total	12	5	6	23	350	150	**500**		50	50	**100**		**Total T+P =600**

Third semester

Sub	Name of subject	Teaching scheme				Assessment of Marks for Theory				Assessment of Marks for Practical				Duration of Paper
		L	T	P/D	To	Paper	CA	Total	Min. for Passing	Univ. Exam	CA	Total	Min. Pass	
IIIFPEPS01	**Power system Dynamics and control**	3	1	-	4	70	30	100	50	-	-	-	-	3Hrs
IIIFPEPS02	**Circuits simulation in PE and PS Design (Lab)**	-	-	6	6	-	-	-	-	50	50	100	50	-
IIIFPEPS03	**Elective 2**	3	1		4	70	30	100	50	-	-	-	-	3 Hrs
IIIFPEPS04	**Project Phase-1 (Seminar)**	-	-	6	6	-	-	-	-	-	100	100	50	-
	Total	6	2	12	20	140	60	**200**	-	50	150	**200**		**Total (T+P) =400**

Fourth semester

Sub	Name of subject	Teaching scheme				Assessment of Marks for Theory				Assessment of Marks for Practical				Duration of Paper
		L	T	P/D	To	Paper	CA	Total	Min. for Passing	Univ. Exam	CA	Total	Min.Pass	
IVFPEPS01	**Project Phase-2 (Dissertation&Viva-voce)**	-	-	12	12	-	-	-	-	200	200	**400**	200	-

Marks of Grand Total of all Four Semesters = 2000

Elective-I	ElectiveII
1.Power quality	**1.Digital Signal Processing**
2.Advanced power System Protection	**2.Artificial Intellegence Based System**
3.Renewable Power Generation Sources	**3.Microcontroller Applications In Power Converters**

Syllabus

M. Tech. (Power Electronics and Power Systems)

FIRST SEMESTER

(1) IFPEPS01 ADVANCED POWER ELECTONICS (Th+ Lab)

Overview of power semiconductor devices – BJT, IGBT, MOSFET, GTO, their characteristics, rating and protection.

Phase controlled converters: AC-DC and AC to AC converters dual converters, converters with improved performance.

Switched mode converter DC-DC PWM Converters AC to DC PWM converters**:** Buck, boost, buck-boost, cuk and full-bridge dc–dc converters, Cycloconverters,

Soft switching converter: Resonant converters, Quasi Reesonant converters topologies, steady.
Inverters: voltage and current source Inverters, Harmonic reduction, UPS .

Multilevel Inverter: principles, topologies, control and applications

Other Advanced converter: Multipulse converters, high power factor converter,

Design of Magnetic components Inductor, HF transformer, line and EMI fitter.

Books:

1. Mohan N. Underland TM, Robbins WP.,"Power Electronics converters, Application and Design", John Wiley & Sons.
2. Rashid M.H. "Power Electronics, circuit, Devices and applications" Prentice Hall of India.
3. Joseph Vithyathil, "Power Electronics Principles and Applications"Tata Mcgrawhill edition.
4. P.C.Sen, " Modern Power Electronics
5. B.K.; Power Electronics and AC Drives; Printice Hall, NJ, 1985.

ii) EEMP1 POWER ELECTONICS PRACTICAL
Experiments based on theory

(2) IFPEPS02 ELECTRIC POWER DISTRIBUTION SYSTEM

Load and Energy Forecasting: Distribution of power, Management, Power loads, Load forecasting, Power system loading, Technological forecasting. Need Based Energy Management (NBEM) – Objectives, Advantages, Distribution Management System (D.M.S.)
Distribution Automation: Definition, Restoration / Reconfiguration of distribution network Different methods and constraints. Interconnection of Distribution, Control & Communication Systems.
SCADA: Introduction, Block diagram, SCADA applied to distribution automation. Common Functions of SCADA, Advantages of Distribution Automation through SCADA.
Calculation of optimum number of switches, capacitors, Optimum Switching Device Placement in Radial. Distribution Systems. Sectionalizing Switches – Types, Benefits. Bellman's Optimality Principle, Remote Terminal Units.
Maintenance of automated distribution systems, Difficulties in implementing distribution automation in actual practice, Urban/Rural Distribution, Energy Management. **Reference Books**

1. Pabla A.S.; Electric Power Distribution (Fourth Edition); Tata McGraw Hill Publishing Co. Ltd., New Delhi 2000.
2. Khedkar M.K.; Learning Material for Electrical Power Distribution 2004.

(3) IFPEPS03 HVDC POWER TRANSMISSION

Development of HVDC Technology, DC versus AC Transmission, Selection of converter configuration.

Rectifier and Inverter operation, Digital Simulation of converters, Control of HVDC converters and Systems, Individual phase control, Equidistant firing controls, Higher level controls.
Characteristics and non-characteristics harmonics filter design.

Fault development and protection, interaction between AC-DC power systems.
Over voltages on AC/DC side, multi-terminal HVDC systems, control of MTDC systems.

HVDC systems, per unit system,
Power flow solution, representation for stability studies.

Reference Books

1. J. Arrillaga.; High Voltage Direct Transmission; Peter Peregrinus Ltd. London, 1983.
2. E. W. Kimbark.; Direct Current Transmission, Vol.I; Wiley Interscience, 1971.
3. K. R. Padiyar.; HVDC Power Transmission Systems; Wiley Eastern Ltd., 1990.
4. Erich Uhlmann.; Power Transmission by Direct Current, B.S. Publications, 2004.

(4) IFPEPS04 POWER SYSTEM MODELLING

Synchronous Machines:
Per unit system and normalization, Park's Transformation, Flux-linkage equations, Voltage and current equations, Formulation of State-space equations, Equivalent circuit, Sub-transient and transient inductance and Time constants, simplified models of synchronous machines.
Steady state: equations and phasor diagram, Determination of machine parameters from manufacturer's data.

Linear model of Single machine Infinite Bus System.

Load Modelling: different types of loads, Transmission line modelling, Modelling of Excitation and Prime mover controllers.

Reference Books
1. Anderson P. M. and Fouad A. A.; Power System Control and Stability.; Galgotia Publications, 1981.
2. Padiyar K. R..; Power System Dynamics, Stability and Control.; Interline Publishing Private Ltd., Banglore1998.
3. Kundur, P.; Power System Stability and Control.; McGraw Hill Inc., 1994.

(5) IFPEPS05 PROCESSOR APPLICATIONS TO ELECRICAL/ POWER SYSTEMS (TH+ Lab)

Review of Microprocessors, Architecture and Programming of 8085 microprocessor, its interfacing with data converters and various programmable interface devices such as multipurpose programmable device 8155, programmable peripheral interface 8255, programmable counter 8254, DMA Controller 8257, Programmable Interrupt controller 8259, and programmable Keyboard / Display interface 8279, Serial I/O and data communication.

Microcontroller, and Microprocessor Architecture and programming of 8051 microcontroller: Special Function Registers, Internal RAM and ROM, Interfacing with external memory, programmable built in ports, on chip counters / timers, Serial Data Input/Output, Interrupts, assembly language Programming and applications.

Op-amp based Analog Signal conditioning circuits, Analysis and Design of Inverting, Non-inverting and Instrumentation amplifiers, Filters and Comparators, Clippers,Clampers and Precision Rectifier circuits.

Microprocessor based applications: Measurement of various electrical and non-electrical parameters, Speed monitoring and control of various motors, Control of firing circuits of power electronics systems, Numerical Protective relays etc.

Reference Books

1. Gaonkar, Ramesh S.; Microprocessor Architecture, Programming and Applications with the 8085; Penram International,1997.
2. Ayala, Kenneth J.; The 8051 Microprocessor Architecture, Programming and Applications; Penram International, 1996.
3. Gayakwad, Ramakant A. ;Op-amps and Linear Integrated Circuits; Prentice Hall of India, 1998.
4. Ram, B.;Fundaments of Microprocessors and Microcomputers; Dhanpat Rai Publications, 2001

(ii) EEMP2 PROCESSOR APPLICATIONS TO POWER SYSYTEM LAB:

Experiments based on theory

SECOND SEMESTER

(6) IIFPEPS01 ADVANCE POWER ELECTRONIC DRIVES (Th + Lab)

Dynamics of Electric Drives: Basic elements of an electric drives, Classification of electric drives, Stability consideration of electric drives.
Analysis of Electric Machinery: Voltage and torque equations in machines variables, theory of direct current machines, Theory of symmetrical induction machines, Theory of synchronous machines, Reference frame theory, Literalized machine equations.

Phase controlled/chopper controlled DC motor drives. Design of controllers, converter selection & its characteristics, harmonics & associated problems. Induction motor drives. **Dynamic modeling of induction machines**. Control principal VSI driven induction motor, vector control and direct torque control drives,
Permanent magnet Synchronous & brushless dc motor drives. Synchronous machines with PMs, control strategies, PMBDC machines.
State variable approach, Scalar / Vector control of induction motors.
Digital Control of Drives: Switch reluctance motors and permanent magnet brushless dc motors.
Reference Books

1. Dubey G.K.; Fundamentals of Electrical Drives; CRC Press, 2002.
2. Krause P.C.; Analysis of Electrical Machinery; McGraw Hill 1987.
3. Bose B.K.; Power Electronics and AC Drives; Printice Hall, NJ, 1985.
4. Leonhard W.; Control of Electrical Drives Narosa Publishing House, India 1984.
5. Bridges I. & Nasar S.A.; Electric Machine Dynamics Macmilan Publishing Company, NY, 1986.
6. Krishnan, R.; Electric Motor Drives, Modelling, Analysis and Control; Prentice Hall India, 2003.

7 Teller T.J.E, Brushless permanent Magnet & Reluctance Motor Drives" clarendom press, Oxford 1989

(6)(a) EEMP3 Advance PE drives Lab: Experiments based on above theory

(7) IIFPEPS07 ADVANCED CONTROL THEORY

State variable: Analysis, Controllability and Observability.

Digital Control Systems, Models of Digital control Devices, State description of Digital processors and sampled continuous time plants, discretization of digital continuous time state equations, Solution of state difference equation.

Controllability and observability tests for digital control systems, Stability of discrete time systems, Pulse transfer function and its realization, Stability improvement by state feedback, Pole-placement design and state observers.

Lyapunov Stability Analysis: Basic concepts, Stability definitions, Stability Theorems, Lyapunov functions for linear and non-linear systems.

Optimal Control: Parameter optimization techniques, Lagrange parameter techniques, Calculus of variations, Unconstrained and Constrained minimization of functional, Two point boundary value problems, Pontrygin's minimum principle, Optimal regulator and tracking problems, Optimal digital control systems.

Reference Books

1. M.Gopal.; Digital Control and State Variable Methods; Tata McGraw Hill, New Delhi, 1997.
2. D.E. Kirk.; Optimal Control Theory; Prentice Hall, 1970.
3. M.Gopal.; Digital Control Engineering; Wiley Eastern, 1988.
4. B.C. Kuo.; Digital Control System Engineering; Saunders College publishing, 1992.

(8) IIFPEPS03: Elective : 1

(A) POWER QUALITY

Origin of power quality variation & events, power quality indices, causes and effects of

power quality disturbances, Characterization of power quality events & event classification. Power quality measuring instruments, Analysis of Power outages, unbalance, distortions, voltage sag, flickers & load balancing.

Modeling of networks and components under non-sinusoidal conditions: transmission and distribution systems, power quality problems created by drives and its impact on drives, Power factor improvement techniques, Passive Compensation, Harmonic Filters

DSTATCOM, DVR and UPQC, Structure & control of power converters, load compensation using DSTATCOM, Generation of reference currents, DVR/UPQC structures & control.

BOOKS RECOMMENDED:

1. Bollen Math H.J., GU Irene Y.H.," Signal Processing of Power Quality Disturbances", Wilely Interscience Publication (IEEE Press),2006
2. Fuchs E.F., Masoum Mohammad A.S, "Power Quality in Power Systems and Electrical Machines", Elsevier Academic Press,2008
3. Bollen Math H.J," Understanding Power quality Problems: Voltage Sags and Interruptions", IEEE Press (Standard Publishers Distributors), 2001.
4. Ghosh A. ,Ledwich G. "Power quality enhancement using Custom Power Devices", Kluwer academic publication-Boston ,2002
5. Moreno Munoz A., "Power quality :Mitigation technologies in a Distributed Environment" Springer 2007
6. Padiyar K.R. "FACTS controller in Power Transmission and Distribution", New Age international, Edition 1st 2007
7. Sankaran C., "Power Quality", CRC Press, Edition 2001
8. Wakileh George J. "Power System Harmonics: Fundamentals, analysis and filter Design, "Springer, (first Indian reprint) 2007.

Elective 1: B ADVANCED POWER SYSTEM PROTECTION

EHV Line Protection of EHV Lines, Distance and carrier protection, Protection on Power swing, Out of step blocking and tripping scheme.

Transformer protection, Machine protection, Alternator and large motors. Bus protection EHV busbar protection. Instrument transformers for relaying, Numerical relying, Sampling anti aliasing filters Algorithm using Fourier transformation based numerical relays and Digital protection.

BOOKS RECOMMENDED:

1. Power system Protection (by Elmore ABB)
2. Power system Protection (Vol.I and II By Warrington
3. Protective relying C.R. Mason.

Elective 1: C RENEWABLE POWER GENERATION SOURCES

Basic characteristics of sunlight-solar energy resource-photovoltaic cell characteristics – equivalent circuit-photo voltaic for battery charging

Wind source-wind statistics-energy in the wind-aerodynamics-rotor types-forces developed by blades-power performance

Wind driven induction generators-power circle diagram-steady state performance-modeling-integration issues-impact on central generation- transmission and distribution systems-wind farm electrical design.

Wind-diesel systems-fuel savings-permanent magnet alternators-modeling-steady state equivalent circuit –self excited induction generators-integrated wind solar systems.

Micro-hydel electric system-power potential –scheme layout-generation efficiency and turbine part flow-isolated and parallel operation of generators-geothermal-tidal and OTEC system.

(1) John F.Walker & Jenkins. N.,' Wind energy Technology', John Wiley and sons, chichester, U.K.1997
(2) Van Overstraeton and Mertens R.P.., 'Physics, , Technology and use of Photovoltaics', Adam Hilger, Bristol,1996
(3) Freries LL,,' Wind Energy Conversion System,' Prentice Hall, U.K. 1990

(9) IIFPEPS04 ENERGY MANAGEMENT SYSTEM

Optimum power flow, Co-ordination of steam, hydro and nuclear power stations.
Optimum generation allocation to thermal units with and without transmission losses, emission dispatch. Hydro-thermal co-ordination, Unit commitment. Loss minimization by reactive power control.
Active and reactive power optimization by non-linear programming method.
Basic components of electrical energy systems such as rotating electric machine, transformers and transmission lines. Methods of energy conservation with an emphasis on fundamentals and rigor. Non conventional energy conversion systems – their energy conversion systems. Energy audit: Industrial energy procedures and documentation techniques, Instrumentation for energy audit.

Reference Books

1. PSR Murthy.; Power System Operation and Control; Tata McGraw-Hill, New Delhi; 1984.
2. L.K. Kirchmayer.; Economic Operation of Power System; Economic Operation of Power System; John Wiley, New York, 1958.
3. A.J. Wood and B.F. Wollenberg.; Power Generation Operation and Control; John Wiley & Sons INC; 1984.

Nagrath and Kothari.; Power System Engineering; Tata McGraw-Hill, 2003.

(10) IIFPEPS05 POWER ELECTRONICS APPLICATIONS TO POWER SYSTEM

Steady state and dynamic problems in AC systems, Power flow

Flexible AC transmission systems (FACTS): Basic realities & roles, Types of facts controller, Principles of series and shunt compensation.

Modelling and Analysis of FACTS controllers. Control strategies to improve system stability. Power Quality problems in distribution systems.

Static var compensators (SVC), Thyristor Controlled series compensators (TCSC), Static phase shifters (SPS), Static condenser (STATCOM), Static synchronous series compensator (SSSC) and Unified power flow controller (UPFC).

Harmonics, harmonics creating loads, modelling, harmonic power flow, Mitigation of harmonics, filters, passive filters.

Active filters, shunt, series hybrid filters, voltage sags & swells, voltage flicker. Mitigation of power quality problems using power electronic conditioners. IEEE standards.

Reference Books

1. Hingorani, N. G.; Understanding of FACTs., IEEE Press 1996.
2. Heydt G.T.; Power Quality.; Stars in a Circle Publications , Indiana, 1991.
3. Miller T.J.E.; Static Reactive Power Compensation.; John Wiley & Sons, New York,1982.
4. Yong Hua Song.; Flexible AC Transmission System. (FACTs).; IEE 1999.
5. Recent Publications on IEEE Journals.

(11) IIFPEPS06 POWER SYSTEM SIMULATION LABORATORY

THIRD SEMESTER

(12) IIIFPEPS01 POWER SYSTEM DYNAMICS AND CONTROL

Representation of Power System: Elements like Synchronous machines, transformers, transmission lines, power semiconductor devices, loads, power system load flow, short circuit studies and power system stability studies using MATLAB-SIMULINK PSCAD, CAPS softwares.

Transient Stability Problem, Augmentation of Transient Stability by Discrete Supplementary Controls, Concept of resynchronization with discrete phase rotation for improvement in transient stability.

Fault analysis of large power systems, Transient stability – Review of classical methods, Dynamic and transient stability investigations and simulation of single machine infinite bus and multi-machine systems.

Transient stability by step by step solution of swing equation, Euler's & modified Euler's method, Runga-kutta method, Transient state phasor diagram of synchronous machine.

Effects of various types of disturbances, parameters and controls on stability, Effect of excitation control. Excitation system modeling, standard block diagram of excitation system.

Augmentation of stability by conventional methods, second swing instability, problems on salient pole synchronous generator. Effect of turbine governor control, simple block diagram,

Reference Books

1. Padiyar K.R.; Power System Dynamics, Stability and Control; B.S. Publications, Hyderabad 2002
2. Kimbark, E.W.; Power system stability, Vol. I & III, John Wiley & Sons, New York 2002

Stagg G.W. & El-Abiad A.H.; Computer Methods in Power System Analysis, McGraw Hill Co., Ltd., Tokyo

(13) IIIFPEPS02 CIRCUIT SIMULATION PE AND PS:

Experiments based on Matlab and Psim Simulation of Power Electronics converter topologies and power system.

(14) IIIFPEPS03 **ELECTIVE 2**

(A)DIGITAL SIGNAL PROCESSING

INTRODUCTION
Signals, systems and signal processing, classification of signal concept of discrete time signals, sampling of analog signal and sampling theorem, anatomy of digital filter.

DISCRETE TIME SIGNALS AND SYSTEMS
Classification , analysis of discrete time signals and systems, implementation of discrete time systems, correlation of discrete time signals, z transform and its application to the analysis of linear time invariant systems.

DISCRETE AND FAST FOURIER TRANSFORMS
Frequency domain sampling, proportion of DFT, efficient computation of DFT : FFT algorithms, Quantization effects in the computation of the DFT.

DIGITAL FILTERS
Structures of FIR and IIR filters, design of FIR filters using windows; Optimum approximations of FIR filters using Parks- McClellan algorithm, Design of IIR filters from analog filters by bilinear transformations; impulse invariance method.

APPLICATIONS OF DSP
Applications of DSP to power system/power electronics/Instrumentation.

BOOKS RECOMMENDED:

1. Proakis-Manolakis, Digital signal Processing, 3rd edition, PHI, 2000.
2. Oppenheim-Schetor, Discrete time signal processing, 2nd edition, Prectice Hall, 1997.
3. Rabiner-Gold, Theory & application of digital signal processing, PHI, 1992.
4. Sanjit Mitra, Digital Signal processing, McGraw-Hill Science/Engineering/Math; 3 edition, 2005.

ELECTIVE2 (B) ARTIFICIAL INTELLIGENCE BASED SYSTEMS

Brief history of artificial intelligence, Comparison with deterministic methods, Aims, objectives of artificial intelligence and current state of the art.

Expert Systems: Introduction to knowledge based systems, Structure and definitions, Knowledge acquisition, Inference engine, Forward and backward chaining, Applications.

Fuzzy Logic: Introduction to concepts, Fuzzy reasoning, Defuzzification, Adaptive fuzzy systems, applications.

Artificial Neural networks: Basic concepts, Back-propagation, Multi-layer networks, Introduction to various paradigms, Learning in neural networks.

Evolutionary Computing (Genetic algorithms): Basic concepts, Applications.

Reference Books

1. Kelvin Warwick.; Arthur Ekwue and Raj Aggarwal.; Artificial Intelligence Techniques in Power Systems.; The Institution of Electrical Engineers, London. 1996.
2. Bart Kosko.; Neural Networks and Fuzzy Systems.; Prentice Hall of India, 1994.
3. Dillon T. S. and Laughtonm M. A..; Expert System Applications in Power Systems.; Prentice Hall International 1995.
4. Dan W. Patterson.; Introduction to artificial intelligence and expert system.; Prentice Hall of India Pvt.Ltd., New Delhi 2004.

Elective 2 (C)MICRO CONTROLLER APPLICATIONS IN POWER CONVERTERS

Evolution of micro-controller – comparison between micro processor and micro controllers- Micro-controller development systems; Microcontrollers-architecture-hardware description.

Addressing modes:- Terminology, Linear addressing, segmented addressing and stack addressing.

Instruction set – arithmetic operations, logical operations, data transfer operations, control transfer operations.

Interrupt structure and Timers; Assembly language programming – C program structure, data acquisition.

Typical application in the control of power electronic converters for power supplies and electric motor drives.

(1) Dauglas V. Hall, "Microprocessor and Interfacing –Programming and Hardware" Tata Mcgraw-Hill, Eleventh edition, 2003

(2) Kenheth J. Hintz and Daniel Tabak, "Microcontrollers – Architecture, Implementation and programming" McGraw Hill, USA, 1992.

(3) John. B. Peatman, 'Design with microcontrollers', McGraw Hill International Ltd., 1997

(15) IIIFPEPS04 Project Phase-1 (Seminar) Seminar on dissertation/Project

FOURTH SEMESTER

(16) IVFPEPS01 Project Phase-2 (Dissertation & Viva-voce) on Project