M.Tech –Power Electronics & Drives (Full Time)

Curriculum and Syllabus
2018 Regulation

I SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MMA18016	Random Process and Optimization Techniques	3	1	0	4
2	MEE18PD001	Advanced Power Semiconductor Devices and Applications	3	1	0	4
3	MEE18PD002	Design and Analysis of Inverters	3	1	0	4
4	MEE18PD003	Design and Analysis of Power Converters	3	1	0	4
5	MEE18XXXX	Elective – I	3	0	0	3
6	MEE18XXXX	Elective – II	3	0	0	3
7	MEE18PDL01	Electrical Drives Laboratory	0	0	2	1
8	MEE18PL02	Renewable Energy Technology Laboratory	0	0	2	1
		TOTAL	**18**	**4**	**4**	**24**

II SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MEE18P009	Modern Distribution System Design and Control	3	1	0	4
2	MEE18PD004	Solid State AC Drives	3	1	0	4
3	MEE18PD005	Solid State DC Drives	3	1	0	4
4	MEE18PD006	Micro Controller based System Design	3	0	0	3
5	MEE18XXXX	Elective – III	3	0	0	3
6	MEE18XXXX	Elective – IV	3	0	0	3
7	MEE18PL03	Advanced Design and Implementation Practice	0	0	2	1
8	MEE18PL04	Scholarly Writing Skills	0	0	2	1
		TOTAL	**18**	**4**	**4**	**23**

III SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MEE18PD007	PWM Techniques in Power Electronics	3	0	0	3
2	MEE18P011	Power Quality and Grid Integration @	3	1	0	4
3	MEE18XXXX	Elective – V	3	0	0	3
4	MEE18XXXX	Elective – VI	3	0	0	3
5	MEE18PDL02	Project Work (Phase –I)	0	0	12	3
		TOTAL	**12**	**0**	**12**	**16**

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IV SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MEE18PDL03	Project Phase – II	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

Summary of Credits:

1st Semester Credits	**22**
2nd Semester Credits	**23**
3rd Semester Credits	**18**
4th Semester Credits	**12**
Total	**75**

The @ indicates that the corresponding course is offered as an internal paper evaluated by the department. The evaluation procedure to be adopted is mentioned in the respective course syllabus.

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ELECTIVE GROUP- I

S.No	Subject Code	Title of Subject	L	T	P	C
1	MEE18PE01	Fuzzy System and Application in Modern Electric Power System	3	0	0	3
2	MEE18PE02	Analysis of Electrical Machines	3	0	0	3
3	MEE18PDE01	Controllers for Power Electronic System	3	0	0	3
4	MEE18DE10	Renewable Energy Technology	3	0	0	3
5	MEE18PDE02	Computer Aided Design of Electrical Machines*	3	0	0	3
6	MEE18P005	Introduction to Soft Computing Techniques	3	0	0	3
7	MEE18PDE03	Digital Control Systems	3	0	0	3
8	MEE18PE14	HVDC Transmission	3	0	0	3

ELECTIVE GROUP - II

S.No	Subject Code	Title of Subject	L	T	P	C
1	MEE18PE15	Advanced Digital Signal Processing	3	0	0	3
2	MEE18PE19	FACTS Controllers	3	0	0	3
3	MEE18PDE04	Industrial Management in Power Electronics	3	0	0	3
4	MEE18PDE11	Advanced Smart Grid Design	3	0	0	3
5	MEE18EE02	Industrial Applications of Drives	3	0	0	3
6	MEE18PE16	Dynamic Modeling and Control of Wind Turbines	3	0	0	3
7	MEE18PE12	System Theory	3	0	0	3
8	MEE18PE08	Power Electronics Applications in Power Systems	3	0	0	3

ELECTIVE GROUP - III

S.No	Subject Code	Title of Subject	L	T	P	C
1	MEE18PDE05	Static VAR Controller and Harmonic Filtering	3	0	0	3
2	MEE18PDE06	Special Machines and Controllers	3	0	0	3
3	MEE18PDE07	EMI Prediction and Analysis	3	0	0	3
4	MEE18PDE08	Embedded System Design	3	0	0	3
5	MEE18EE11	Advanced Microprocessor and Microcontroller Design	3	0	0	3
6	MEE18PDE09	Switched Mode and Resonant converters	3	0	0	3
7	MEE18PE17	Micro Grid in Modern Power Systems	3	0	0	3
8	MEE18PE11	Intelligent Optimization Techniques and Application in Modern Power Systems	3	0	0	3

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MMA1801 APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS 3 1 0 4

OBJECTIVES:

- Capable to solve the problems arises in Electrical field.
- Understand the concept of Calculus.
- The student will be capable of solving Integral Equations.

UNIT I RANDOM VARIABLES 12 hours

Random variables – Distribution functions – Moments – Moment generating functions – Two dimensional Random variables – Marginal and conditional distributions

UNIT II RANDOM PROCESS 12 hours

Classification of Random Process – Stationary Process – Ergodic Process – Markov Process – Markov Chains – Auto Correlation – Auto Covariance – Cross Correlation – Cross Covariance – Spectral Density

UNIT III SPECIAL FUNCTIONS 12 hours

Bessel's equation – Bessel functions – Recurrence relations – Generating function – Orthogonal property – Legendre's equation – Legendre Polynomials – Rodrigue's formula

UNIT IV CALCULUS OF VARIATIONS 12 hours

Variation and its properties – Euler's equations – Functionals dependent on First and higher order derivatives – Functionals depend on functions of several independent variables – Problems with moving boundaries – Direct methods – Ritz and Kantorovich methods

UNIT V INTEGRAL EQUATION 12 hours

Types of Integral equations – Fredholm integral equation – Volteera integral equation – Green's function – Fredholm integral equations with Separable kernels – Iterative methods for solving equations of second kind – Properties of Symmetric kernels

Tutorials:15
Total no. of Hours: 60

References:

1. Richard Johnson A., Miller & Freund's Probability and statistics for Engineers (8th ed.), Prentice Hall of India, (2009).
2. Veerarajan T., Probability, Statistics and, Random Processes, Tata McGraw Hill Publishing Co., (2008).
3. Gupta S.C., Kapoor V.K., Fundamentals of Mathematical Statistics, S.Chand & Co., (2007).
4. Venkataraman M.K., Higher Mathematics for Engineering and Science, The National Publishing Co., (2006).
5. Gupta A.S., Calculus of variations with applications, Prentice Hall of India, (2004).
6. Raisinghania M.D., Integral Equations and Boundary value problems (3rd ed.), S.Chand & Co., (2010).
7. Hildebrand F.B., Methods of Applied Mathematics, Dover Books, (1992).

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MEE18PD001 **ADVANCED POWER SEMICONDUCTOR DEVICES AND APPLICATIONS** **3 1 0 4**

OBJECTIVES:

- Understands the concepts of power switching Devices
- Capability to design Firing circuits
- Ability to design protection for circuits

UNIT I: Introduction **9 Hours**

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching – Power diodes - Types, forward and reverse characteristics, switching characteristics – Rating.

UNIT II: Current Controlled Devices **9 Hours**

BJT's – Construction, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power darlington – Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – Steady state and dynamic models of BJT &Thyristor.

UNIT III: Voltage Controlled Devices **9 Hours**

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs – Basics of GTO, MCT, FCT, RCT and IGCT.

UNIT IV: Firing and Protecting Circuits **9 Hours**

Necessity of isolation, pulse transformer, opto-coupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers.

UNIT V: Thermal Protection **9 Hours**

Heat transfer – conduction, convection and radiation; Cooling – Liquid cooling, vapour – Phase cooling; Thermal modeling of power switching devices: Thermal equivalent circuit, Coupling of electrical & thermal components, heat sink types and design – Mounting types.

Tutorials:15
Total no. of Hours: 60

REFERENCE BOOKS:

1. Mohan .N, Undeland& Robbins, Power Electronics – Converters, Application & Design, John Wiley & Sons, Inc, 2nd Edition, Newyork, 2001.
2. Simon M.Sze& Kwok K.Ng, Physics of semiconductor devices, A Wiley Interscience Publication, John Wiley and Sons(2007),3rd Edition.
3. Dieter K.Schroder, Semiconductor Materiual and Device Characterization, A John Wiley and Sons Inc Publication, IEEE press, 3rdEdition 2006.
4. Robert F.Pierret, Semiconductor Device Fundamental", Addition Wesly Publishing Company
5. Donald A.Neamen, Semiconductor Physics and Devices – Basic Principles, McGraw Hill, 2003.
6. Robert.F.Pierret, Advanced Semiconductor Fundamentals, Prentice Hall Piblisher, 2nd Edition (2002).

M.Tech –Power Electronics & Drives (Full Time)

MEE18PD002 DESIGN AND ANALYSIS OF INVERTERS 3 1 0 4

OBJECTIVES:

- Understands the concepts of Inverters
- Analyse the current & voltage source Inverters
- Attains knowledge about Resonant Pulse Inverters

UNIT I: Single Phase Inverter 9 Hours

Introduction – Principle of operation – Performance parameters – Single phase half bridge Inverters – Single phase full bridge Inverter – Single phase Series Inverter – Single phase parallel Inverter - Voltage control of single phase Inverters

UNIT II: Three Phase Voltage Source Inverter 9 Hours

Modified McMurray Inverter – McMurray Bedford half bridge and full Inverter – Three phase bridge Inverter with1800 and 1200 mode of operation – Voltage control of three phase Inverters.

UNIT III: Current Source Inverter 9 Hours

Analysis of single phase and three phase auto sequential current source Inverter - Current source bridge Inverter– Harmonic Elimination Techniques.

UNIT IV: Multilevel Inverter 9 Hours

Multilevel concept – Diode clamped – Flying capacitor – Cascade type multilevel Inverters - Comparison of multilevel Inverters - Application of multilevel Inverters

UNIT V: Resonant Pulse Inverters 9 Hours

Introduction – Series resonant Inverters with unidirectional and Bidirectional switches – Parallel resonant Inverters– Class E resonant Inverter - Zero current switching resonant converter – Zero voltage switching resonant converter– Two quadrant ZVS resonant converter – Resonant DC link Inverter.

Tutorials:15
Total no. of Hours: 60

References:

1. Rashid M.H, Power Electronics – Circuits, Devices & Applications, Prentice Hall of India, 3rd Edition, New Delhi, 2005.
2. P.S.Bimbra, Power Electronics, Khanna Publishers, Eleventh Edition, 2003
3. Mohan .N, Undeland& Robbins, Power Electronics – Converters, Application & Design, John Wiley & Sons, Inc, 2nd Edition, Newyork, 2001.
4. P.C Sen, Modern Power Electronics, Wheeler publishing Co, First Edition, New Delhi-1998.
5. Rashid M.H., Hand book on Power Electronics.
6. M.D. Singh & K.B. Khanchandani, Power Electronics, Tata McGraw Hill Publishing Company Limited, 2nd Edition, Fourth Print 2009.

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MEE18PD003 DESIGN AND ANALYSIS OF POWER CONVERTERS 3 1 0 4

OBJECTIVES:

- Understands the concepts of Converters
- Analyse the buck boost converter
- Capable to apply the Matrix converter

UNIT I :Single Phase Rectifiers 9 Hours

Introduction – Principle of phase controlled converter operation – Single phase full converter with R, RL and RLE loads – Effect of Free wheeling diodes – Effect of source inductance – Single phase semi converter – Single phase dual converter – Single phase series converter.

UNIT II :Three Phase Rectifiers 9 Hours

Three phase half wave converter – Three phase semi converter – Three phase full converter with RL loads. –Effect of source and load inductance **-** Three phase dual converter – Power factor improvements

UNIT III: DC Choppers 9 Hours

Introduction – Principles of step-down operation, step-down chopper with RL load – Principle of step-up operation with resistive load – Converter classification – Switching mode regulators – Analysis of buck, boost, buck boost and CUK converter – Comparison of regulators – Multi output boost converter.

UNIT IV: AC Choppers 9 Hours

Introduction – Principle of ON-OFF control – Principle of phase control – Single phase bidirectional controllers with resistive loads – Single phase controllers with Inductive loads – Three phase half wave and full wave controllers– Three phase bi-directional delta connected controllers.

UNIT V :Cycloconverter And PWM Techniques 9 Hours

Cycloconverters – Single phase step up and step down cycloconverer – Single phase to three phase cycloconverter – Three phase to single phase cycloconverter **-** Reduction of output Harmonics **-** AC voltage controllers with PWM control – Matrix converter.

Tutorials:15
Total no. of Hours: 60

References:

1. Rashid M.H, "Power Electronics Circuits, Devices & Applications", Prentice Halll of India, 3rd Edition, New Delhi, 2005,
2. P.S.Bimbra, " Power Electronics", Khanna Publishers, Eleventh Edition, 2003
3. Mohan .N, Undeland& Robbins, "Power Electronics Converters, Application & Design", John Wiley & Sons, Inc, 2nd Edition, Newyork, 2001
4. P.C Sen, "Modern Power Electronics", Wheeler publishing Co, First Edition, New Delhi-1998.
5. M.D. Singh & K.B. Khanchandani, "Power Electronics", Tata McGraw Hill Publishing Company Limited, 2nd Edition, 2009.
6. M.S.JamilAsghar, "Power Electronics", PHI Learning Private Ltd, 2004, (Seventh printing 2009).
7. V.R.Moorthi, "Power Electronics Drives, Circuits, and Industrial Applications," Oxford University press, First published in India 2005,

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MEE18PDL01 ELECTRICAL DRIVES LABORATORY 0 0 2 1

LIST OF EXPERIMENTS

1. Introduction to the DSP-based E l e c t r i c - D r i v e s S y s t e m
2. Simulation and Real-time Implementation of a Switch-mode DC Converter
3. Switch-mode DC Converter and NoLoad DC Motor Test
4. Open loop control of DC Drive with load
5. Controller design for DC Motor speed control
6. Four-Quadrant Operation Of Dc-Motor
7. Current Controlled PMAC Machine
8. Determination Of Induction Machine Parameters
9. Torque speed characteristics and speed control of Three phase induction motor
10. Safety precautions and power-electronics drives board Cp1104 i/o board, ds1104 control board and motor coupling Unit familiarization

References:

1. http://www.ece.umn.edu/groups/power/labs/ed/ed_manual.pdf
2. http://www4.hcmut.edu.vn/~nvnho/Download/DS1104%20Doc/dsp%20DS1104%20Electric%20Drives_lab.pdf

Total no. of Hours: 45

MEE18PL02 RENEWABLE ENERGY TECHNOLOGY LABORATORY 0 0 2 1

OBJECTIVES:

- Students will develop the ability to apply software and hardware Implementation of what they have learned theoretically in the field of Renewable energy.
- In this Laboratory, students will obtain knowledge about specific wind power; calculate the wind frequency, turbine characteristics, time period and the frequency of the rotating turbine at different speeds.
- To understand the concept of semiconductors and p-n junctions energy band, to study the Effect of Light, Effect of Temperature, Effect of Parasitic Resistance, to plan, design, simulate solar photovoltaic and also to understand hardware interface for simulation, Characterization of solar cells/PVs are the component of renewable energy systems sizing/selection of PV modules, battery.
- To familiarize the students with the Efficiency of a Flat Plate Solar Collector, I-V Characteristics and Efficiency of a Solar PV cell , Analysis of Flat Plate Collector, studies on Solar thermal systems for residential water heating, industrial heating and power generation, solar collector.

Total no. of Hours: 45

MINI PROJECTS:

1. Case study report on design of power supply to Duplex home. Design an Innovative Structure of wind blade and small ratings of wind mill.
2. Design a demo model for Solar water heater, Solar cooker, Battery for solar energy storage and solar lamp
3. Students can choose any innovative ideas of their own interest, based on the above OBJECTIVES.

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MEE18P009 MODERN DISTRIBUTION SYSTEM DESIGN AND CONTROL 3 1 0 4

OBJECTIVES:

- Able to design concepts related with the planning of modern power distribution system with the integration of distributed generation.
- Aims at preparing students to conduct research or helping them to improve their research skills.

UNIT I: Introduction to Distribution System Planning 9 Hours

Introduction – Factor Affecting System Planning – Planning Techniques- Future Planning Factors – Role of Computer in Planning – Importance and Impact of Distributed Generation consideration in Planning – Load Characteristics – Load Forecasting – Load Management

UNIT II: Design of Distribution Substation and Automation 9 Hours

Introduction – Types – Planning Techniques - Substation Cost – Bus Scheme – Location – Rating – Comparison of four and six feeder pattern – Derivation of K Constant - Design consideration for Remote Terminal Units - Components for Distribution Substation Automation – Power Transformers – Substation Protection Schemes- Substation Earthing and Grounding – Distribution Automation – Substation - Feeder level and Customer level Automation – Control Center Architecture.

UNIT III: Design of Primary and Secondary Distribution System 9 Hours

Introduction – Types of Primary Feeders - Methods – Radial Feeders with Distributed Loads – Application of ABCD Constants – Overhead and Underground Design Consideration – Cost Analysis – Secondary Feeder Voltage level and Design Practice – Secondary Banking – Secondary Networks – Spot Networks – Economic Design of Secondary's - Cost Analysis

UNIT IV: Application of Capacitor in Distribution System 9 Hours

Basic Definition – Effect of Series and Shunt Capacitors – Power Factor Correction – Application of Capacitor – Economic Justification for Capacitor – Mathematical Procedure to Determine the Location of Capacitor - Practical Procedure to Determine the Location of Capacitor – Dynamic Behavior of Distribution System – Application of AI Techniques in Optimal Capacitor Location.

UNIT V: Future of Distribution System 9 Hours

Introduction – Concept of distributed generations, topologies, selection of sources, regulatory standards/Framework, Standards for interconnecting Distributed resources to electric power distribution systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels.

Tutorials:15
Total no. of Hours: 60

References:

1. Turan Gonen, (2012) Electrical Power Distribution System Engineering. Taylor & Francis Group. CRC Press.
2. MIT Study Report (2012) Future of grid.http://mitei.mit.edu/system/files/Electric_Grid_Full_Report.pdf
3. IEEE Tutorial Distribution Automation.

M.Tech –Power Electronics & Drives (Full Time)

MEE18PD004 **SOLID STATE AC DRIVES** **3 1 0 4**

OBJECTIVES:

- Understand the operation of different types of loads
- Knowledge on Vector control
- Describes the brushless excitation system.

UNIT I: Stator Voltage Control of Induction Motor **9 Hours**

Torque-Slip characteristics, Equivalent circuit, Speed control – Variable Voltage, Variable Frequency, Constant V/F operation. Operation with different types of loads, Performance, Comparison of different AC power controllers- Speed reversal, Closed loop control.

UNIT II: Stator Frequency Control **9 Hours**

Operation of induction motor with non sinusoidal supply waveforms, Variable frequency operation of 3 phase induction motors, Constant flux operation, Current fed operation, Dynamic and regenerative braking of CSI and VSI fed drives.

UNIT III: Rotor Resistance Control **9 Hours**

Torque, Slip characteristics, Types of rotor choppers, Torque equations, Constant torque operation, TRC strategy-Closed loop speed control.

UNIT IV: Slip Power Recovery Scheme **9 Hours**

Equivalent circuit, Torque equation, Torque - Slip characteristics - Power factor considerations - Sub synchronous operation and closed loop speed control, Vector or Field control - Direct Vector control.

UNIT V: Synchronous Motor Drives **9 Hours**

Need for leading PF operation - Open loop VSI fed drive and its characteristics - Self control - Torque angle control - Power factor control - Brush less excitation system - Starting methods - Principles of vector control.

Tutorials: 15
Total no. of Hours: 60

References:

1. Murphy,J.M.D, Turnbull F.G., "Thyristor control of AC motors", Peramon Press, Oxford, 2005.
2. B.K.Bose, "Power Electronics & AC drives", Dorling Kindersley India, 2002.
3. Dubey .G.K., "Power Semiconductor Controlled Drives", Prentice Hall International, Newyork, 1999.
4. Dewan.S.B. Slemon, G.R. Straughen.A., "Power semiconductor drives", John wiley and sons, Newyork, 1994.
5. I.J.Nagrath&D.P.Kothari, "Electrical Machines", Tata Publications, 2nd Edition, Eighth Edition, Reprint 2001.
6. V.R.Moorthi, "Power Electronics Drives, Circuits, and Industrial Applications," Oxford University press, First published in India 2005, (sixth impression 2008).

M.Tech –Power Electronics & Drives (Full Time)

MEE18PD005 **SOLID STATE DC DRIVES** **3 1 0 4**

OBJECTIVES:

- Understand the operation of different types of loads
- Knowledge on Vector control
- Describes the brushless excitation system.

UNIT I: Review of Conventional DC Drives **9 Hours**

Different techniques of speed control and methods of braking of series and separately excited DC motor, Ward Leonard speed control, Model and transfer function of series and separately excited DC motor.

UNIT II: Converter Control of DC Motors **9 Hours**

Analysis of series and separately excited DC motor with single phase and three phase converters operating indifferent modes and configurations, Problems on DC machines fed by converter supplies, drive employing dual converter.

UNIT III: Chopper Control of DC Motors **9 Hours**

Introduction to time ratio control and frequency modulation; Class A,B,C,D and E chopper controlled DC motor–Performance analysis, multi-quadrant control – Chopper based implementation of braking schemes – Multiphase Chopper.

UNIT IV: Design of Converter and Chopper for DC Drives **9 Hours**

Speed loop, P, PI, PID controllers, Current loop, Armature current reversal, Field current reversal - Digital controller and firing circuits, Simulation.

UNIT V: Design of Controller **9 Hours**

Closed loop control with current & speed feedback – Armature Voltage control and field weakening mode control - Design of Current controller- Speed Controller – Converter selection & Characteristics.

Tutorials: 15
Total no. of Hours: 60

References:

1. Buxbaum.A, Schierau.K and Staughem, “A Design of Control Systems for D.C.Drives”, Springer - Verlag, Berlin, 1996.
2. Dubey .G.K , “Power Semiconductor Controlled Drives”, Prentice Hall International, New jersey, 1998.
3. Sen P.C, “Thyristor D.C Drives”, John Wiley & Sons, Newyork, 2001.
4. Subrahmanyam .V, “Electric Drives Concept and Applications”, Tata McGraw Hill Publishing Co., LTD., New Delhi, 1995.
5. Siemen’s Course Material
6. www.automation.siemens.com

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MEE18PD006 MICROCONTROLLER BASED SYSTEM DESIGN 3 0 0 3

OBJECTIVES:

- To gain knowledge of the latest microcontrollers like RL78 and PIC16F877A
- To educate on the interrupts, timers, peripheral devices for data communication and transfer
- To gain knowledge to design and build a real-time system performing data-capture, communications, and user interface

UNIT I: Introduction of Rl78 9 Hours

Introduction about RENESAS Family of microcontrollers, RL78 Processor Core basics, Block Diagram, Data flow diagram within core, Instruction set, Addressing Modes, RL78 Pipeline structure, Implementation of C language statements in RL78Assembly language, Programming Examples, Software development tools for RL78.

UNIT II: Rl78 Interrupts and Timer Peripherals 9 Hours

RL78 Interrupt mechanism, Interrupt processing activities: both hardware and software with ISR examples, Interrupt Characteristics, RL78 Interrupt vector table, Concurrent Interrupt, External Interrupt. Timers: Timer Array Unit: Independent Channel Operation Modes, Simultaneous Channel Operation Modes - Using PWM Mode to Control a Servo Motor, Programming Examples

UNIT III: Serial Communication 9 Hours

Basic Concepts: Synchronous, Asynchronous, Example Protocols: CSI, UART, I2C, Serial Array Unit Concept: CSI Mode, UART Mode, Simplified IIC Mode, Serial Communications Device Driver Code, Programming Examples for serial communication

UNIT IV: PIC Microcontroller 9 Hours

Introduction to PIC Microcontroller, PIC16F877A Architecture, Pin Description, Peripheral Features, Analog Features, Pipelining, Program Memory considerations, Register File Structure, Instruction Set, Addressing modes, Advantages of PIC

UNIT V: Interfacing with PIC Microcontroller 9 Hours

Interfacing: LCD Display, Keypad Interfacing, Generation of Gate signals for converters and Inverters, Motor Control, Controlling AC appliances, Measurement of frequency, Stand alone Data Acquisition System

Total no. of hours: 45

References:

1. Alexander, G.,Conrad, M (2012),Embedded Systems using Renesas RL78 Microcontroller, Micrium Press
2. Ganssle, J.(2008),The Art of Designing Embedded systems, Newnes
3. RL78 Family User" s Manual: RENESAS Electronics, 2011
4. http://microcontrollerslab.com/pic16f877a
5. http://www.microchip.com
6. www.circuitstoday.com.

MEE18PL03 ADVANCED DESIGN AND IMPLEMENTATION PRACTICE 0 0 2 1

The Procedure for execution of Advanced Design and Implementation Practice are

- Each student has to select their own topic which is in real time operation.
- Develop the mathematical model for the suitable selected topic.
- Optimize the finalized process plan with suitable selection of equipments.
- Prepare the cost analysis with breakeven chart.
- Finalize the implementation model for action.
- Simulate the finalized model with suitable simulation package.
- Implement the developed design in real or prototype category.

The end semester examination will be conducted internally in the department with suitable presentation by the student with design and implementation report.

M.Tech –Power Electronics & Drives (Full Time)

MEE18PL04 **SCHOLARLY WRITING SKILLS** **0 0 2 1**

OBJECTIVES:

- The student will be familiar with research articles
- The student will learn the nuances of writing a research article
- The student will be capable of paraphrasing and summarizing the research findings

TOPICS TO BE COVERED

- What is a research paper?
- Steps in writing research paper
- Structure of a research paper
- Choosing a Topic
- Narrowing and Limiting the Topic
- Finding and Selecting Sources (Book, Article, Other)
- Proposing a Working Thesis
- Note Taking
- Outlining
- Referencing
- Final Organization of Paper
- Final Drafting (Putting It All Together)
- Proof Reading

Total no. Hours 45

Evaluation Process:

The student needs to select any one of the core theory paper and draft a scholarly article on the same in IEEE template and submit the same for evaluation in the department at the end of the semester.

Note: Technical English will also be play an important role in evaluation.

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MEE18PD007 PWM TECHNIQUES IN POWER ELECTRONICS 3 0 0 3

OBJECTIVES:

- Understand the various switching schemes
- Analys the Space vector modulation
- Determination of dq component.

UNIT I : Inverter Control Strategy **9 Hours**

Inverter – Operation principle – Inverter switching – Unipolar – Bipolar – Inverter dead time – Inverter Modulation– Different types – Trapezoidal modulation – Third harmonics Modulation – Analysis of third harmonics modulation –Output filter requirement for different PWM techniques.

UNIT II: PWM Techniques **9 Hours**

Pulse Width Modulation – Equal pulse PWM – Random PWM – Output Voltage – Harmonics – Sinusoidal PWM– Basic concepts – Modulation function – Switching schemes – Signal generation – Output voltage harmonics – Exact expression for q.

UNIT III: Space Vector Modulation (SVM) **9 Hours**

Space Vector Modulation – (Two Level Inverter) : Concept of a space vector – dq components for three phase sine wave source / level – dq VSI Inverter switching states - Under modulation region – Calculation of V_a & V_b–SVM Modulation Index – Derivation of formula for Derivation of new Ta, Tb &T0 – Pulse pattern for three phases.

UNIT IV: SVM over Modulation Regions **9 Hours**

Over modulation region – Over modulation mode 1 – Modified reference voltage trajectory – Derivation of new Ta, Tb – Equation of various voltage segments – Over modulation mode 2 - Modified reference voltage trajectory - Derivation of new Ta, Tb – Equation for various voltage segments.

UNIT V: Implementation of SVM in TMS 320F2407 **9 Hours**

Flow diagram – Calculate the d-q component of Vout – Calculate the Ta,Tb&T0 – Determine the switching sequence - Sine look up table for frequency calculation.

Total No. of. Hours= 45

References:

1. Mohammed H.Rashid, “Power Electronics – Circuits, Devices and Applications”, Eastern Economy Edition, Third Edition 2004.
2. Bimal K Bose, “Modern Power Electronics and AC Drives”, Pearson Education Asia, 2003.
3. IssBatarseh, “Power Electronic Circuits”, John Wiley &Sons Inc. 2004.
4. Hamid A.Toliyat & Steven G.Campbell, “DSP Based Electro Mechanical Motion Control”, CRC press.
5. Grahame Holmes .D, Thomas A.Lipo, “Pulse Width Modulation for Power Converters, Principles and Practice” – IEEE Press – 2003.
6. F.Blaabjerg, J.K. Pedersen and P.Thoegersen, “Improved Modulation Techniques for PWM-VSI drive", IEEE Trans. On Industrial Electronics, Vol.44, No.1, Feb 1997, pp.87-95.

MEE18P011 POWER QUALITY AND GRID INTEGRATION@ 3 1 0 4

OBJECTIVES:

- Understand the importance and causes of transients.
- Understand the sources of transient over-voltages and its causes.
- Understand the effect of harmonics in industrial and commercial loads.

UNIT I: Introduction 9 Hours

Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage unbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

UNIT II: Measurement and Analysis Methods 9 Hours

Voltage, Current, Power and Energy measurements, power factor measurements and definitions, event recorders, Measurement Error – Analysis: Analysis in the periodic steady state, Time domain methods, Frequency domain methods: Laplace, Fourier and Hartley transform – The Walsh Transform – Wavelet Transform.

UNIT III: Analysis and Conventional Mitigation Methods 9 Hours

Analysis of power outages, Analysis of unbalance: Symmetrical components of Phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples – Harmonic indices – Analysis of voltage sag: Detorit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction.

UNIT IV: Power Quality Improvement 9 Hours

Utility-Customer interface –Harmonic filters: passive, Active and hybrid filters –Custom power devices: Network reconfiguring Devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC –control strategies: P-Q theory, Synchronous detection method – Custom power park –Status of application of custom power devices.

UNIT V: Grid Integration and Power Quality 9 Hours

Stand alone and Grid Connected WECS system- Basics of Grid Connection; Characteristics of Wind Generator; State-of-the-art of power Electronics in Wind Energy - Soft-starter, Capacitor bank, Rectifiers and inverters, Frequency converters. Power Converters for WECS; Power Quality Standards in Wind Farms- Reactive power, flicker coefficient, Maximum number of wind turbine switching operations, flicker step factor, Voltage change factor, Harmonic currents.

Total no. of Hours: 45

References:

1. Dranetz--BMI; NJATC (2010) Power Quality Analysis. 2010 Ed. (Dranetz-BMI and NJATC).
2. Luisa Martinez Muneta, Gregorio Romero Rey, and Teodora Smiljanic, (Nov 23, 2011) Power Quality Harmonics Analysis and Real Measurements Data.
3. Antonio Moreno-Muñoz, (Dec 10, 2010) Power Quality: Mitigation Technologies in a Distributed Environment (Power Systems).
4. Mohammed Hasan Ali, (Feb 16, 2012) Wind Energy Systems: Solutions for Power Quality and Stabilization.

Evaluation Process

- For 50 marks written examination will be conducted by the department using OBE
- The remaining 50 marks to be allocated for Innovative Learning Practice (IPL) like development of prototype, new design development, paper publication and field training. All these mentioned IPL should be accompanied by a 25 pages report in an appropriate format as mentioned in ISO

MEE18PE01 FUZZY SYSTEM AND APPLICATION IN MODERN ELECTRIC POWER SYSTEM 3 0 0 3

OBJECTIVES:

- Understand the mathematical adaptation of fuzzy systems.
- Capable to Control Power Network.
- Capable to detect and diagnose in rotating machines.

UNIT I: Fuzzy Logic and Its Controllers 9 Hours

Fuzzy set - Crisp set – vagueness – uncertainty and imprecision – fuzzy set –fuzzy operation- properties – crisp versus fuzzy relations – fuzzy relations –fuzzy Cartesian product and composition – composition of fuzzy relations-Fuzzy to crisp conversion –structure of fuzzy logic controller – database – rule base – Inference engine.

UNIT II: Fuzzy Application to power system Operation 9 Hours

Overview-Load Forecasting-Economic Dispatch-Unit commitment using Fuzzy concepts

UNIT III: Control of Electrical Energy Systems 9 Hours

Automatic Generation Control (AGC) and Reactive Power control using: classical, optimal-Fuzzy control techniques. Energy Storage Devices to Power System Control using Fuzzy concepts

UNIT IV: Power system Stability Control 9 Hours

Introduction-Types-Voltage Stability Control-Angle Stability Control-stability assessment using Fuzzy concepts.

UNIT V: Fault Deduction and Diagnosis 9 Hours

Introduction –Transmission line fault Diagnosis-Rotating machines fault-transformer fault-transmission fault-using Fuzzy concept. Application of fuzzy logic to identify different types of Machines Faults.

Total no of hours: 45

References:

1. Timothy J. Ross,(1997) Fuzzy Logic with Engineering Applications. McGraw Hill International Edition.
2. Hawary, E.L.(1998) Electric Power Applications of Fuzzy Systems. IEEE Press.
3. Klir, G. J. and Yuan, B. Fuzzy Sets and Fuzzy Logic.
4. Loi Lei Lai, Intelligent System Application in Power Engineering .

M.Tech –Power Electronics & Drives (Full Time)

MEE18PE02 **ANALYSIS OF ELECTRICAL MACHINES** **3 0 0 3**

OBJECTIVES:

- Understands the basics of EM energy conversion
- Able to analyse the different electrical machines
- Capable of designing electrical machines

UNIT I: Principles of Electromagnetic Energy Conversion **9 Hours**

Basic principles of Electric Machine Analysis - Electromagnetic energy conversion – Linear and non linear magnetic System – Winding configuration in rotating machines and air gap configuration - Force and torque equations of Co-energy and energy equations – Winding inductances and voltage equations

UNIT II: DC Machines **9 Hours**

Analysis of steady state operation of DC Machine – Permanent Magnet DC Machine- Voltage and torque equations – dynamic characteristics of DC Machine shunt DC motors –Analysis of Steady State Performance – Permanent Magnet DC Machines - Analysis of Shunt, Series Excited motors, Laplace transformation – dynamic characteristics -Digital computer simulation of DC Machines

UNIT III: Reference Frame Theory **9 Hours**

General aspects of Reference Frame Theory–Stationary Reference Frame, Synchronously rotating Reference Frame, Arbitrary Reference Frame – Advantages of Reference Frame Transformations - phase transformation and commutator transformation – observation from several frames of reference.

UNIT IV: Induction Machines **9 Hours**

Equivalent Circuit of Three phase induction machine, simulink implementation of steady state operation – Controller design – voltage and torque equations in machine variables and arbitrary reference frame variables – analysis of Load torque variations – dynamic performance, digital computer simulation.

UNIT V: Synchronous Machines **9 Hours**

Analysis of steady state operation of Three phase synchronous machine, Simulink implementation of steady state operation – voltage and torque equations in machine variables and arbitrary reference frame variables – analysis of Load torque variations – dynamic performance, digital computer simulation.

Total no. of Hours: 45

References:

1. Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, Second Edition, 2010.20
2. P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2008.
3. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, " Electric Machinery", Tata McGraw Hill, 5th Edition, 1992

M.Tech –Power Electronics & Drives (Full Time)

MEE18PDE01	CONTROLLERS FOR POWER ELECTRONIC SYSTEM	3	0	0	3

OBJECTIVES:

- Understands the Architecture of various microprocessor
- Ability to design various firing scheme
- Application of Microprocessor in Power electronics

UNIT I: Review of Microprocessors **9 Hours**

Architecture and Programming of 8085 and 8086, A/D and D/A converters, Interfacing of 8253, 8255, 8155 and other important interfacing ICs

UNIT II: Microprocessor Based Firing Scheme for Converters **9 Hours**

Firing schemes for single phase and three phase rectifiers-3-phase AC choppers, Firing at variable frequency environments, Firing scheme for DC choppers, voltage and current communication, Inverters, types of pulse width modulation techniques- implementation using microprocessors, Application of these firing schemes to the control of DC drive, induction motors, synchronous motors and other special machines, Application in Electrical Traction.

UNIT III: Microprocessors in Closed Loop Control Schemes **9 Hours**

Importance of measurement and sensing in closed loop control, Measurement of voltage, current, speed, power and power factor using microprocessors, Implementation of various types of controllers using microprocessors.

UNIT IV: Microprocessors in Special Applications of Power Electronics **9 Hours**

Static excitation of synchronous generators, Solid State tap-changers for transformers, UPS systems, Induction furnace control.

UNITV: Basic Sensing and Measurement **9 Hours**

Measurement techniques for on-line measurement of DC and AC voltages, currents and phase angle, Digital implementation of P PI and PID controllers

Total no. of Hours: 45

References:

1. Gaonkar, R.S., "Microprocessor Architecture ", Programming and Application with 8080/8085 "Wiley Eastern Limited, New Delhi, 2000.
2. Hall, D.V. "Microprocessors and Interfacing ", McGraw-Hill Publishing Company, New Delhi,1 986.
3. William Kleitz,' Microprocessor and Microcontroller Fundamentals of 8085 and 8051 hardware and Software', Pearson Education,1998.

M.Tech –Power Electronics & Drives (Full Time)

MEE18S003 RENEWABLE ENERGY TECHNOLOGY 3 0 0 3

OBJECTIVES:

- Understands various Renewable energy
- Ability to design microgrid
- Knowledge on Fuel cells.

UNIT I: Wind Turbines 9 Hours

Wind source – wind statistics-energy in the wind – aerodynamics-rotor types- forces developed by blades-aerodynamic models- braking systems- tower - control and monitoring system- power performance.

UNIT II: Photo-Voltaic 9 Hours

Basic characteristics of sunlight-solar energy resource- photovoltaic cell-characteristics equivalent circuit-photovoltaic fort battery charging- charge regulators- equipments and systems

UNIT III: Geothermal, Tide and Wave Energy 9 Hours

Availability of Geothermal Energy-size and Distribution, Recovery of Geothermal Energy, Various Types of Systems to use Geothermal Energy, Direct heat applications, Power Generation using Geothermal Heat, Sustainability of Geothermal Source, Status of Geothermal Technology, Economics of Geothermal Energy.

UNIT IV: Biomass, Bio-fuels 9 Hours

Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels, Biochemical and Thermo-chemical Conversion, Combustion, Gasification, Biomass gasifiers and types etc.
Bio-fuels: Importance – Types- , Production processes and technologies, Bio fuel Applications

UNIT V: Hydrogen Energy & Fuel Cell 9 Hours

Hydrogen as a renewable energy source, Sources of Hydrogen, Fuel for Vehicles. Hydrogen Production- Direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production, Storage of Hydrogen- Gaseous, Cryogenic and Metal hydride. Fuel cell – Principle of working, construction and applications.

Total no. of Hours: 45

Reference Books :

1. N.K.Bansal and M.K.Kleeman "Renewable Sources of Energy and Conversion Systems:".
2. John F. Walker & Jenkins, N., 'Wind Energy Technology', John Wiley and sons, Chichester, U.K., 1997.
3. Freries LL, 'Wind Energy Conservation Systems', Prentice Hall, U.K., 1990.
4. Kreith and Kreider (Solar Energy Handbook: McGrawHill)
5. T. Ohta , " Solar Hydrogen Energy Systems - (Ed.) (Pergamon Press)
6. Van Overstraeton R.J. and Mertens R.P., Adam Hilger, Bristol 'Physics, echnology and use of Photovoltaics', ,1996
7. D.A.Maths , Hydrogen Technology for Energy – (Noyes Data Corp.)
8. S.T.Rama, E.Sheeba Percis, A.Nalini, S.Bhuvaneswari (2017), Handbook on Standalone Renewable Energy Systems, Research India Publication, ISBN 978-93-87374-12-6

MEE18PDE02 COMPUTER AIDED DESIGN OF ELECTRICAL MACHINES 3 0 0 3

OBJECTIVES:

- Understands various design procedure of machines
- Ability to model different machines.

UNIT I: Introduction **9 Hours**

Conventional design procedures – Limitations – Need for field analysis based design.

UNIT II: Mathematical Formulation of Field Problems **9 Hours**

Electromagnetic Field Equations – Magnetic Vector/Scalar potential – Electrical vector /Scalar potential – Stored energy in field problems – Inductance - Development of torque/force - Laplace and Poisson's Equations – Energy functional - Principle of energy conversion.

UNIT III: Philosophy of FEM **9 Hours**

Mathematical models – Differential/Integral equations – Finite Difference method – Finite element method – Energy minimization – Variation method - 2D field problems – Discretisation – Shape functions – Stiffness matrix – Solution techniques

UNIT IV: CAD Packages **9 Hours**

Elements of a CAD System – Pre-processing – Modeling – Meshing – Material properties - Boundary Conditions– Setting up solution – Post processing

UNIT V: Innovative Learning Practice **9 Hours**

Design of Solenoid Actuator – Induction Motor – Insulators – Power transformer

Total no. of Hours: 45

Reference Books :

1. S.J Salon, "Finite Element Analysis of Electrical Machines", Kluwer Academic Publishers, London, 1995.
2. S.R.H.Hoole, "Computer – Aided, Analysis and Design of Electromagnetic Devices", Elsevier, New York, Amsterdam, London, 1998.
3. P.P. Silvester and Ferrari, "Finite Elements for Electrical Engineers", Cambridge University press, 1998.
4. D.A.Lowther and P.P Silvester, "Computer Aided Design in Magnetics", Springer verlag, New York, 1997.
5. A.K.Sawhney, "A Course in Electrical Machine Design", DhanpatRai& Co, 5th Edition, Reprint 2002.

MEE18P005 INTRODUCTION TO SOFT COMPUTING TECHNIQUES 3 0 0 3

OBJECTIVES:

- To familiarize with soft computing concepts, feed forward , feedback neural networks and learning methods.
- To expose to the concepts of Fuzzy Logic, Genetic algorithm and its applications to soft computing.
- To gain knowledge about the hybrid systems

UNIT I: Fundamentals of Neural Networks and Artificial Neural Networks 9 Hours

Introduction to Neural Networks, Fuzzy Logic, Genetic Algorithm, Hybrid Systems and Soft Computing
Artificial Neural Network: Introduction, Fundamental Concept, Basic Models, important Terminologies of ANNs, McCulloch-Pitts Neuron, Hebb Network, Supervised Learning Networks: Introduction, Perceptron Networks, Adaptive Linear Neuron (Adaline), Multiple Adaptive Linear Neurons. Back-Propagation Network: Architecture, Learning, Applications, Selection of various parameters

UNIT II: Artificial Neural Networks 9 Hours

Associative Memory Networks: Introduction, Training Algorithms for Pattern Association, Auto-associative Memory Network, Hetero-associative Memory Network, Bidirectional Associative Memory (BAM),Hopfield Networks .Counter-propagation Networks: Architecture, functioning & characteristics of counter Propagation network, Hopfield/ Recurrent network, configuration, stability constraints, associative memory, and characteristics, limitations and applications. Hopfield v/s Boltzman machine - Adaptive Resonance Theory: Architecture, classifications, Implementation and training.

UNIT III: Introduction to Fuzzy Logic 9 Hours

Introduction, Classical Sets and Fuzzy Sets, Classical Relations and Fuzzy Relations, Properties of Membership Functions, Fuzzification, and Defuzzification, Fuzzy Arithmetic and Fuzzy Measures, Fuzzy Rule Base and Approximate Reasoning, Fuzzy Decision Making

UNIT IV: Introduction to Genetic Algorithm and Hybrid Systems 9 Hours

Genetic Algorithm**:** Introduction, Traditional Optimization and Search Techniques, Genetic Algorithm and Search Space, General Genetic Algorithm, Operators in Generic Algorithm, Stopping Condition, Constraints, Advantages and Limitations and Applications of Genetic Algorithm.
Hybrid Systems: Integration of Neural Networks, Fuzzy Logic and Genetic Algorithms, GA Based Back Propagation Networks, Fuzzy Associative Memories, and Simplified Fuzzy ARTMAP.

UNIT V: Applications of Soft Computing in Electrical Engineering 9 Hours

Introduction, Application of Generalized Neuron Models to Electrical Machine Modeling, Electrical Load Forecasting Problem, Load Frequency Control Problem

Total no. of Hours: 45

References:

1. Timothy J. Ross (2010) Fuzzy Logic with Engineering Applications, 3rd Edition, Wiley India.
2. Jacek M. Zurada, (1999) Introduction to Artificial Neural Systems. Jaico Publishing House.
3. Wassermann, P.D. (1989) Neural computing: Theory and Practice, Van Nostrand Reinhold Company
4. Rajasekaran,S, Vijayalakshmi Pai,G.A,(2011) Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI Learning Private Ltd.
5. Dr. Sivanandam, S. N. ,Dr. Deepa, S. N.(2007) Priniciples of Soft Computing, Wiley India
6. Chaturvedi, Devendra K(2008), Soft Computing Techniques and its Applications in Electrical Engineering, Springer
7. Padhy, N.P. (2005) Artificial Intelligence and Intelligent Systems, Oxford University Press.
8. Zimmermann, H.J. (2001) Fuzzy set Theory and its Application Springer Science+Business Media, LLC
9. David E. Gold Berg,(1996) Genetic Algorithms in Search, Optimization and Machine Learning,
10. Addison Wesley Publishing Company

M.Tech –Power Electronics & Drives (Full Time)

MEE18PDE03 **DIGITAL CONTROL SYSTEMS** **3 0 0 3**

OBJECTIVES:

- Understands the basics of discrete time control systems
- Ability to apply state variable techniques
- Ability to design Controllers

UNIT I: Introduction **9 Hours**

Introduction to discrete time control system **-** Sampling and holding **-** sample and hold device **-** D/A, A/D conversion – sampling theorem – data interpolation Z transform –properties **-** inverse Z transform **-** Pulse transfer function

UNIT II: State Variable Technique **9 Hours**

State equations of discrete time systems – solution of state equation **-** state transition matrix, its properties – state space realization and state diagram – pulse transfer function from state equation **-** characteristic equation **-** Eigen values **-** Eigen vectors. Similarity transformation – transformation into various canonical forms

UNIT III: Controllability, Observability and Stability **9 Hours**

Controllability and observability of Linear Time Invariant (LTI) discrete data systems – tests for controllability and observability **-** relationship between controllability, observability and pulse transfer functions, Stability of LTI discrete time systems **-** Jury's stability tests – Schur **-** Cohn stability test **-** Bilinear transformation method **-** Lyapunov stability analysis.

UNIT IV: Controller Design – I **9 Hours**

Classical approach **-** Correlation between root locations in Z-plane and time response **-** direct digital design in Z and W plane (under bilinear transform **-** State space approach **-** State feedback **-** Design via pole placement – observer based state feedback **-** Introduction to digital redesign.

UNIT V: Controller Design – II **9 Hours**

Kalman filter – optimal state estimation – optimal controllers – LQR, LQG frameworks – Extended Kalmanfilter.PID controller – Digital PID controller design.

Total no. of Hours: 45

References:

1. K.Ogata, "Discrete time control systems", 2nd edition, Pearson Edu., 2003.
2. Franklin, Powell, workman, "Digital control of Dynamic systems", 3rd edition, Pearson Edu., 2002.
3. M.Gopal, "Digital Control and state variable methods", Tata McGraw hill, New Delhi, 2003.
4. AashishTiwari, "Modern control design with MATLAB and SIMULINK", John Wiley and sons Ltd., 2002
5. Benjin.Kuo, 'Digital Control systems', 2nd Edition, Oxford University, 1992.

MEE18PE14 **HVDC TRANSMISSION** **3 0 0 3**

OBJECTIVES:

- Comparison of DC & AC systems.
- Analyze the HVDC Converters.
- Modeling and design of filters.

UNIT I: Introduction to HVDC **9 Hours**

Comparison of AC & DC- Application, Description and planning of DC Transmission – Modern trends in HVDC transmission - Recent developments in switching devices.

UNIT II: Analysis of HVDC converters **9 Hours**

Pulse number – Choice of Converter Configuration – Simplified analysis of Graetz circuit – Converter bridge characteristics – Characteristics of twelve pulse converter – Detailed analysis of converters.

UNIT III: Converter and system control **9 Hours**

Principles of DC link control – Converter control Characteristics - system control hierarchy – Firing angle control – Current and extinction angle control - Starting and stopping of DC Link – Higher level controllers.

UNIT IV: Converter faults and protection **9 Hours**

Converter Faults – Protection against over currents – Over voltages in a converter station & Protection - Smoothing Reactor - DC Line – Transient overvoltages in DC line – Protection of DC line – Effect of proximity in AC and DC Transmission line

UNIT V: Harmonics & Filters, MTDC system **9 Hours**

Generation of Harmonics - Design of AC Filters – DC Filters - MTDC Systems – types, control & Protection.

Total no. of Hours: 45

References:

1. K.R.Padiyar , HVDC Power Transmission Systems, New Academic Science, 2011
2. Kamakshaiah, HVDC Transmission, TMH Education, 2011
3. Jos Arrilaga , High Voltage Direct Current Transmission, 2nd Edition, IEEE, 1998

MEE18PE15 **ADVANCED DIGITAL SIGNAL PROCESSING** **3 0 0 3**

OBJECTIVES

- To enable the students to get the fundamentals of parametric and non-parametric analysis
- To enable the students to design adaptive filters using different methodologies

UNIT I: Discrete Random Signal Processing **9 Hours**

Discrete Random Process, Expectation, Variance, Co-Variance, Scalar Product, Energy of Discrete Signal-Parseval's Theorem, Wiener Khintchine Relation-Power Spectral Density –Periodogram – Sample Autocorrelation-Sum Decomposition Theorem, Spectral Factorization Theorem – Discrete Random Signal Processing by Linear Systems-Simulation of White Noise – Low Pass Filtering of White Noise.

UNIT II: Spectrum Estimation **9 Hours**

Non-Parametric Methods-Correlation Method – Co-Variance Estimator – Performance Analysis of Estimators – Unbiased, Consistent Estimators – Periodogram Estimator – Bartlett Spectrum Estimation – Welch Estimation – Model based Approach – AR, MA, and ARMA Signal Modeling – Parameter Estimation using Yule-Walker Method.

UNIT III: Linear Estimation and Prediction **9 Hours**

Maximum likelihood criterion-efficiency f estimator – Least mean squared error criterion – Wiener filter – Discrete Wiener Hoff equations – Recursive estimators-Kalman filter – Linear prediction, prediction error-whitening filter, inverse filter – Levinson recursion, Lattice realization, and Levinson recursion algorithm for solving Teoplitz system of equations.

UNIT IV: Adaptive Filters **9 Hours**

FIR adaptive filters – Newton's steepest descent method-adaptive filter based on steepest descent method – Widrow Hoff LMS adaptive algorithm – Adaptive channel equalizations – Adaptive echo chancellor – Adaptive noise cancellation – RLS adaptive filters –Exponentially weighted RLS – sliding window RLS – Simplified IIR LMs adaptive filter

UNIT V: Multi Rate Digital Signal Processing **9 Hours**

Mathematical description of change of sampling rate – Interpolation and Decimation –continuous time model – Direct digital domain approach **-**Decimation by an integer factor – Interpolation by an integer factor – single and multistage realization **-** Poly phase realization – Application to sub band coding – Wavelet transform and filter bank implementation of wavelet expansion of signals.

Total No. of Hours: 45

References:

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc., New York, 1996
2. John G. Proakis, Dimitris G. Manolais, "Digital Signal Processing Prentice Hall of India", 1995.
3. Sopocles J. Orfanidis, "Optimum Signal Processing", McGraw Hill, 1990.

MEE18PE19 | **FACTS CONTROLLERS** | **3 0 0 3**

OBJECTIVES:

- To understand the need and concept of flexible AC transmission and the associated problems
- To gain knowledge about the characteristics, applications and modeling of series and shunt FACTS controllers.
- To study the operation of controllers for enhancing the transmission capability.
- To analyze the interaction of different FACTS controllers and perform control coordination

UNIT I: Introduction **9 Hours**

Introduction, Basics of Power Transmission Networks, Control of Power Flow in AC Transmission Line, Transmission problems and needs: emergence of FACTS, Concept of FACTS Controllers, FACTS controllers – Need, types, benefits & applications in Distribution Systems. Analysis of uncompensated AC Transmission line, reactive power control in electrical power transmission lines - Line compensation - Principle, Types, Compensation by FACTS devices.

UNIT II: Static VAR Compensators **9 Hours**

Static shunt compensators: SVC and STATCOM, Operation and control of TSC, TCR and STATCOM Methods of Controllable VAR Generation, Static VAR Compensators: SVC and STATCOM, Comparison, Static VAR Systems, Voltage control by SVC, Advantages of slope in dynamic characteristics, Influence of SVC on system voltage, Modeling of SVC for power flow and stability studies, Applications, Harmonics and Filtering, Protection Aspects.

UNIT III: Static Series Compensators **9 Hours**

Objectives of Series Compensation, Variable Impedance Type Series Compensators, Switching Converter Type Series Compensator, External (System) Control for Series Reactive Compensators, Modeling of TCSC and GCSC for load flow studies, stability studies - Applications of TCSC and GCSC, SSR mitigation

UNIT IV: Co-Ordination of FACTS Controllers **9 Hours**

Introduction, FACTS Controller interactions - SVC-SVC, SVC-HVDC, TCSC-TCSC, SVC-TCSC, Performance Criteria for Damping - Controller Design, Coordination of Multiple Controllers Using Linear-Control Techniques, Coordination of Multiple Controllers using Nonlinear-Control Techniques, Quantitative treatment of control Co-ordination.

UNIT V: Emerging FACTS Controllers **9 Hours**

Introduction, Mechanically Switched Capacitors (MSC/MSCDN), SSSC, UPFC - Principle, modes of operation, applications, modeling, IPFC, GIPFC and HPFC, SMES, Comparative Evaluation of FACTS Controllers, Future Direction of FACTS Technology

Total no. of Hours: 45

References:

1. Hingorani, N.G., Gyugyi, L. (2001), Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, IEEE Press Book, Standard Publishers and Distributors, Delhi.
2. Padiyar , K. R. (2007), FACTS Controllers in Power transmission and Distribution, New Age International (P) Limited, Publishers
3. Yong-Hua Song, Allan Johns,(1999), Flexible Ac Transmission Systems (FACTS), IET
4. Mohan Mathur, R., Rajiv K. Varma (2002), Thyristor-Based FACTS Controllers for Electrical Transmission Systems, Wiley-IEEE Press
5. John, A.T.(1999), Flexible AC Transmission System, Institution of Electrical and Electronic Engineers (IEEE)
6. http://www.energy.siemens.com/hq/en/power-transmission/facts/
7. http://spectrum.ieee.org/energy/the-smarter-grid/flexible-ac-transmission-the-facts-machine
8. http://www.electrical4u.com/facts-on-facts-theory-and-applications/

M.Tech –Power Electronics & Drives (Full Time)

MEE18PDE04 INDUSTRIAL MANAGEMENT IN POWER ELECTRONICS 3 0 0 3

OBJECTIVES:

- Understand the management technologies
- Analyse of various power circuits
- Knowledge on the AC-DC Circuits

UNIT I: Power Management Technologies 9 Hours

Introduction, Integrated Circuits Power Technology - Processing and Packaging – Diodes and Bipolar Transistors- MOS Transistor - DMOS Transistors - CMOS Transistors - Passive Components, Discrete Power Technology - Processing and Packaging - Power MOSFET.

UNIT II: Analog Circuits 9 Hours

Analog Circuits –Transistors – NPN – PNP Transconductance - Transistor as Transfer Resistor – Transistor Equation, Elementary Circuits - Current Mirror - Current Source – Buffer - Differential Input Stage, Operational Amplifier- Inverting and Non Inverting Amplifier, Voltage Reference, Voltage Regulator, Switching Regulators, Digital Circuits -Logic Function - NAND Gate - Set Reset R Flip Flop.

UNIT III: Converters and DC-DC Conversion Architectures 9 Hours

Buck Converters - Switching Regulator Power Train - Output Capacitor - Electrolytic Capacitor and Transient Response - Ceramic Capacitors - Losses in the Power Train - The Analog Modulator - Driver -Switching Regulator Control Loop, Flyback Converters, DC-DC Conversion - Valley Control Architecture - Monolithic Buck Converter - Battery Charging Techniques.

UNIT IV: AC-DC Architectures 9 Hours

Power Architecture - PFC Architecture - DC-DC Conversion Down to Low Voltage - Power AC Adapter – DDR Power Management Architecture.

UNIT V: Future Directions and Special Applications 9 Hours

Voltage Regulation with Power Factor Correction, Green Power (Energy Management), Motor Drivers For Portable Electronic Applications - Camera Basics - Motor And Motor Drivers - Drive Implementation, Efficiency - DSC Power consumption.

Total no. of Hours: 45

References:

1. Dr.Nazzareno Rossetti, “Managing Power Electronics: VLSI & DSP Driven Computer Systems”, A John Wiley & Sons, Inc., 2006.
2. Muhammad H.Rashid, “Power Electronics Hand BooK”, Elsevier Inc., 2nd Edition 2007.
3. Steve Doty, Wayne C.Turner, “Energy Management Hand Book”, The Fairmont Press, 7th Edfition 2009.
4. Paul R.Gray, Paul J.Hurst, Stephen H.Lewis and Robert G.Meyer “Analysis and Design of Analog Integrated Circuits”, John Wiley & Sons, Inc., 2009.
5. Liv, Kramer, Indiver, Delbruck Douglors, “Analog VLSI: Circuits and Principles”, Massachusetts Institute of Technology, 2002.

M.Tech –Power Electronics & Drives (Full Time)

MEE18PDE11 **ADVANCED SMART GRID DESIGN** **3 0 0 3**

OBJECTIVES:

- Capable to design various levels of smart grid.
- Capable to develop cyber security standards in smart grid
- Capable to integrate systems.

UNIT I: Pathway for Designing Smart Grid **9 Hours**

Introduction- Barrier & Solution to Smart Grid Development- Solution pathway for Design of Smart Grid using Advanced Optimization and control Techniques for selection Functions- General level Automation- Bulk Power System Automation of Smart Grid- Distribution System Automation Requirement of Power Grid- End User-Appliance level of the Smart Grid- Application for Adaptive Control & Optimization.

UNIT II: Renewable Energy & Storage **9 Hours**

Renewable Energy resources- Sustainable Energy options for Smart Grid- Penetration & Variability Issues Associated with Sustainable Energy Technology- Demand Response Issues- Electric Vehicle and Plug In Hybrids-PHEV Technology- Environmental Implication- Storage Technology- Tax Credit.

UNIT III: Interoperability, Standards & Cyber Security **9 Hours**

Introduction- Interoperability-Standards- Smart Grid Cyber Security- Cyber Security & Possible Operation for Improving Methodology for other user.

UNIT IV: Fast Forward to Smart Grid **9 Hours**

Smart Grid Emergence- Rationale for an Advanced Smart Grid- Smart Convergence- Smart Grid Enterprise Architecture- Envisioning & Designing the Energy Internet-Today's Smart Grid- Advanced Smart Grid Complexities-Grid Operation- Market Operation- Revolutionary Smart Grid Tools- Smart Grid Architecture Frame (SGAF)- Smart Grid Optimization Engine(SGOE)- From Static to Dynamic Grid Operations – Grid Journey- NFTE & FE.

UNIT V: Research, Education & Training for the Smart Grid **9 Hours**

Introduction- Research Areas for Smart Grid Development- Research Activities in Smart Grid

Total no. of Hours: 45

References:

1. James Momoh, SMART GRID-Fundamentals of Design and Analysis' published in John Wiley, IEEE Press.
2. Andres Carallo & John Cooper The Advanced Smart Grid –Edge Power Driving Sustainability by. ISBN_13:978-1-60802-127-2
3. S.T.Rama, E.Sheeba Percis, A.Nalini, S.Bhuvaneswari (2017), Handbook on Standalone Renewable Energy Systems, Research India Publication, ISBN 978-93-87374-12-6
4. Stuart Borlase Smart Grids: Infrastructure, Technology, and Solutions (Electric Power and Energy Engineering) by (Jan 1, 2012)
5. Tony Flick and Justin More house, Securing the Smart Grid: Next Generation Power Grid Security by (Oct 7, 2010)

M.Tech –Power Electronics & Drives (Full Time)

MEE18EE02 INDUSTRIAL APPLICATIONS OF DRIVES 3 0 0 3

OBJECTIVES:

- Understand the Dynamics of Drives
- Application of High power Industrial Drives
- Study about the Heating & Cooling of motors.

UNIT I: Introduction 9 Hours

Requirements of an adjustable speed drive – Forms of drive motors – AC drives versus DC drives – Trends in drive Technology

UNIT II: Dynamics of Electric Drives 9 Hours

Introduction – Classification electric drive – Basic elements of an Electric drive – Dynamic conditions of a drive system – Stability condition of electric drive – Selection of motors – Characteristics of motors for variable speed drives.

UNIT III: Rating and Heating of Motors 9 Hours

Requirements of a drive motor –Power losses and heating of electric motors – Heating and cooling curves of an electric power – classes of duty – selection of design ruling motor.

UNIT IV: Drives for Specific Applications 9 Hours

Introduction **-** Drives and motors for textile mills – Steel rolling mills – Cranes and Hoist drives –Cement mills – Sugar mills – Machine tools – Paper mills – Coal mines – Centrifugal mills – Turbo compressors – Traction. A review of thyristorised DC and AC drives.

UNIT V: High Power Industrial Drives 9 Hours

Introduction – Drive rating classification with speed and power ratings – Versatility of DC drive and Limitations at large power and high speed **-** Thyristorised of DC drive and Limitations at large power and induction motor drives at high power level – a short survey of the evaluation of large power drive – Synchronous motor drives – Load commutated converter motor fed from a CSI – Operating modes of motor – Converter – Motor plus converter – implementation of the system – converter for high power – cooling system – fault tolerant design – Reduction of line harmonics and improvement of line power factor – Applications.

Total no. of Hours: 45

References:

1. Vedam Subrahmanyam , Electric Drives, Concepts and Applications , TMH, 2000.
2. Richard M. Crowder, Electric Drives and Their Controls, Clorendon, Oxford 2003.

M.Tech –Power Electronics & Drives (Full Time)

MEE18PE16 DYNAMIC MODELING AND CONTROL OF WIND TURBINES 3 0 0 3

OBJECTIVES:

- Understand the concepts of Power Electronic Devices for wind turbine.
- Capable to design modeling of wind turbines.
- Capable to design the mechanical equations for Induction Machines.

UNIT I: Generators & Power Electronics for Wind Turbines 9 Hours

Introduction – State of the art technologies – Overview of Wind Turbine Topologies – Power Control Concepts – State of the art Generators – State of the art Power Electronics – Generator Concepts – Power Electronic Concepts – Power Electronic Solutions in Wind Farms.

UNIT II: Introduction to the Modeling of Wind Turbines 9 Hours

Introduction - Basic Considerations regarding Modeling and Simulations - Overview of Aerodynamic Modeling - Basic description of the turbine rotor - Different representations of the turbine rotor - Basic Modeling Block - Description of Wind Turbines - Aerodynamic system - Mechanical system - Generator drive concepts - Pitch servo Main control system - Protection systems and relays - Per Unit Systems and Data for the Mechanical System - Different Types of Simulation and Requirements for Accuracy - Simulation work and required modeling accuracy Different types of simulation

UNIT III: Reduced-Order Modeling of Wind Turbines 9 Hours

Introduction - Power System Dynamics Simulation - Current Wind Turbine Types - Modeling Assumptions - Model of a Constant-speed Wind Turbine - Model structure - Wind speed model - Rotor model - Shaft model - Generator model - Model of a Wind Turbine with a Doubly fed Induction Generator - Model structure - Rotor model - Generator model - Converter model - Protection system model - Rotor speed controller model - Pitch angle controller model - Terminal voltage controller model - Model of a Direct drive Wind Turbine - Generator model - Voltage controller model - Model Validation - Measured and simulated model response - Comparison of measurements and simulations.

UNIT IV: High-Order Models of Doubly-Fed Induction Generators 9 Hours

Introduction - Advantages of Using a Doubly-fed Induction Generator - The Components of a Doubly-fed Induction Generator - Machine Equations - The vector method - Notation of quantities - Voltage equations of the machine - Flux equations of the machine - Mechanical equations of the machine - Mechanical equations of the wind turbine - Voltage Source Converter - Sequencer - Simulation of the Doubly-fed Induction Generator - Reducing the Order of the Doubly-fed Induction Generator.

UNIT V: Full-Scale Verification of Dynamic Wind Turbine Models 9 Hours

Introduction - Background - Process of validation - Partial Validation - Induction generator model - Shaft system model - Aerodynamic rotor model - Summary of partial validation - Full-scale Validation - Experiment outline - Measured behavior - Modeling case - Model validation - Discrepancies between model and measurements.

Total no. of hours: 45

References:

1. Thomas Ackerman ,Wind Power in Power Systems. John Wiley & Sons Ltd.
2. Olimpo Anaya-Lara, Nick Jenkins, Janaka Ekanayake, and Pill Cartwright, (Aug 31, 2009) Wind Energy Generation: Modeling and Control.
3. S.T.Rama, E.Sheeba Percis, A.Nalini, S.Bhuvaneswari (2017), Handbook on Standalone Renewable Energy Systems, Research India Publication, ISBN 978-93-87374-12-6
4. (Jul 21, 2012) Dynamics Modeling and Loads Analysis of an Offshore Floating Wind Turbine. National Renewable Energy Laboratory (NR).
5. Loi Lei Lai, and Tze Fun Chan, (Nov 28, 2007) Distributed Generation: Induction and Permanent Magnet Generators.
6. Thomas Ackermann, (Mar 28, 2005) Wind Power in Power Systems.

M.Tech –Power Electronics & Drives (Full Time)

MEE18PE12 **SYSTEM THEORY** **3 0 0 3**

OBJECTIVES:

- Understands the fundamentals of Control System
- Analyse the system characteristics
- Ability to maintain stability.

UNIT I: Introduction **9 Hours**

State space modeling of physical systems –determining of STM – controllability and observability of linear time invariant system

UNIT II: Non-Linearity System **9 Hours**

Different techniques of line arising in non-linear systems – Describing functions for various types of non-linearity's – describing function analysis of non linear control systems

UNIT III: Analysis of Systems **9 Hours**

Method of constructing phase – trajectories- phase plane analysis of linear and non-linear systems – Bang-bang system

UNIT IV: Stability Criteria **9 Hours**

Stability of LTI Systems - Different methods of constructing Lyapunov's functions for linear and non-linear continuous time systems

UNIT V: Pole Placement **9 Hours**

Pole placement technique by state feedback for linear SISO time invariant system – Theory of high-gain feedback-advantages – Pole placement technique along with high-gain feedback control

Total no. of Hours: 45

References

1. M. Gopal, & Madan, "Modern Control System Theory", New Age International, 3rd edition, 2014.
2. D. Roy Choudhury, "Modern Control Engineering", PHI Learning Pvt. Ltd, 2005.
3. Ogata, K. (2003) Modern Control Engineering.5th Ed. Prentice Hall of India, 2009
4. Kuo. B.C. Automatic Control Systems. Hoboken, NJ Wiley 2010,

M.Tech –Power Electronics & Drives (Full Time)

MEE18PE08 POWER ELECTRONICS APPLICATIONS IN POWER SYSTEMS 3 0 0 3

OBJECTIVES:

- Capable to regulate and control voltage using Thyristors.
- Familiarity to converters, UPS and frequency devices.
- Capable to improve power factor of converters

UNIT I: Static VAR Control 9 Hours

Principles of load compensation – voltage regulation and power factor correction – unsymmetrical loads – phase balancing and power factor Corrections – static compensation properties – Thyristor controlled Reactor (TCR), Thyristor switched capacitor (TSC), saturable core reactor (control strategies)

UNIT II: Power Factor Improvement and Harmonic Control Converters 9 Hours

Poor power factor – forced commutation techniques for power factor improvement – methods of improving the power factor of the line commutated converters – use of high frequency devices.

UNIT III: Voltage Control 9 Hours

Static Tap changer for voltage control – Static Tap changing using thyristors –comparison of different schemes – Generator excitation – schemes, comparison.

UNIT IV: Uninterrupted Power Supply 9 Hours

Parallel redundant & non-redundant UPS, UPS using frequency devices, Resonant converters, Switched mode power supplies

UNIT V: Unified Power Flow Control 9 Hours

Implementation of power flow control using conventional thyristors, implementation of Unified power flow controller.

Total no. of Hours: 45

References:

1. Miller, T.J.E. (1982), Reactive Power control in Electric Systems, New York: Wiley Interscience.
2. Yoshihide Hase, Handbook of Power Systems Engineering with Power Electronics Applications, 2nd Edition, 2012, wiley
3. Gyugyi, L.(July 1994) Unified Power Flow Control Concept for Flexible AC Transmission. Vol. 139. IEEE proceedings

M.Tech –Power Electronics & Drives (Full Time)

MEE18PDE05 STATIC VAR CONTROLLER AND HARMONIC FILTERING 3 0 0 3

OBJECTIVES:

- Understand the concept of Reactive power
- Application of Harmonic filters
- Study of Multipurpose converters.

UNIT I: Introduction 9 Hours

Fundamentals of Load Compensation, Steady-State Reactive Power Control in Electric Transmission Systems, Reactive Power Compensation and Dynamic Performance of Transmission Systems, Power Quality Issues. Sags, Swells, Unbalance, Flicker, Distortion, Current Harmonics, Sources of Harmonics in Distribution Systems and its Effects

UNIT II: Reactive Power Compensation 9 Hours

Static Reactive Power Compensators and their control, Shunt Compensators, SVCs of Thyristor Switched and Thyristor Controlled types and their control, STATCOMs and their control, Series Compensators of Thyristor Switched and Controlled Type and their Control, SSSC and its Control, Sub-Synchronous Resonance and damping, Use of STATCOMs and SSSCs for Transient and Dynamic Stability Improvement in Power Systems

UNIT III: Static Compensation 9 Hours

Converters for Static Compensation, Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM), GTO Inverters, Multi-Pulse Converters and Interface Magnetics, Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM), Multi-level inverters of Cascade Type and their modulation, Current Control of Inverters.

UNIT IV: Harmonic Filtering – I 9 Hours

Passive Harmonic Filtering, Single Phase Shunt Current Injection Type Filter and its Control, Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modeling, Three-phase four-wire shunt active filters, Hybrid Filtering using Shunt Active Filters, Series Active Filtering in Harmonic Cancellation Mode.

UNIT V: Harmonic Filtering – II 9 Hours

Current Harmonics, Sources of Harmonics in Distribution Systems and its Effects, Series Active Filtering in Harmonic Cancellation Mode, Series Active Filtering in Harmonic Isolation Mode, Dynamic Voltage Restorer and its control, Power Quality Conditioner.

Total no. of Hours: 45

References:

1. T.J.E Miller , Reactive Power Control in Electric Systems
2. N.G. Hingorani & L. Gyugyi , Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems, IEEE Press, 2000.

M.Tech –Power Electronics & Drives (Full Time)

MEE18PDE06	**SPECIAL MACHINES AND CONTROLLERS**	**3**	**0**	**0**	**3**

OBJECTIVES:

- Understand the concept of Special Machines
- Ability to design controllers
- Study of novel motors.

UNIT I: Stepper Motors **9 Hours**

Introduction to stepper motor - Constructional features and principle of operation - Single phase stepper motors- Single stack variable reluctance stepper motor - Modes of excitation- Multi - stack stepper motor – Electromagnetic torque developed in reluctance motor - Effect of saturation - Static and dynamic characteristics - PM stepper motor, Hybrid Stepper motor, Enhanced PMH stepper motor, Disc Magnet stepper motor, Electro hydraulic stepper motor - construction and operation - Drive circuits for stepper motor – Open loop control and Closed loop control of stepping motor - Applications of stepper motor.

UNIT II: Switched Reluctance Motors **9 Hours**

Constructional features - Principle of operation - Torque equation - Power electronic converter circuits - Characteristics and control - Torque-speed Characteristics, Current sensing - Rotor position measurement and estimation- Sensorless rotor position estimation; Incremental inductance measurement and constant flux linkages method – Control of SRM for traction type load.

UNIT III: Permanent Magnet Brushless DC Motors **9 Hours**

Commutation in DC motor - Difference between mechanical and electronic commutators - Hall effect sensors - Optical sensors - Multiphase brushless motor - Square wave permanent magnet brushless motor drives - Torque and EMF equation – Torque - speed characteristics – Controllers

UNIT IV: Permanent Magnet Synchronous Motors **9 Hours**

Construction and operation of synchronous motors; d-q transformation and d-q model - Closed loop control ind-q reference frame - Vector control of permanent magnet synchronous motors - DTC of VSI and CSI fed electrically excited synchronous motors.

UNIT V: Novel Motors **9 Hours**

Construction and operation of Written pole motors - Piezoelectric Motors - Bearingless motors - Slotless motors– Coreless Stator PM brushless motors; Disc type coreless motors, Cylindrical type motors with coreless stator winding- Super conducting electric machines.

Total no. of Hours: 45

References:

1. Miller. T.J.E. "Brushless permanent magnet and reluctance motor drives", Clarendon Press, Oxford, 2007.
2. Kenjo. T, "Stepping motors and their microprocessor control", Clarendon Press, Oxford, 2008.
3. R.Krishnan, "Switched Reluctance Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.
4. J.F.Gieras, "Advancements In Electrical Machines", Springer publisher Dec 2008
5. Kenjo, T and Nagamori, S, "Permanent Magnet and brushless DC motors", Clarendon Press, Oxford, 2003.
6. K.Venkataratnam, "Special Electrical Machines", University press Private Limited 2008.
7. V.V.Athani, "Stepepr Motors-Fundamentals, Applications and Design" New Age International (P) Limited, Publishers (2006).

MEE18PDE07 EMI PREDICTION AND ANALYSIS 3 0 0 3

OBJECTIVES:

- Understand the concept of EMI
- Knowledge of shielding
- Ability to model the interferences

UNIT I: Introduction 9 Hours

EMP environments- causes of EMI- basic EMP environment- relationship with other effects- EMC practices.

UNIT II: Sources of Inferences 9 Hours

Conductive and Radiated Inference- sources- characteristics and design methods to eliminate inference.

UNIT III: Method of Hardening 9 Hours

Effects on components - protective techniques - shielding - grounding -filtering – surge Diverters.

UNIT IV: Mathematical Modeling 9 Hours

Mathematical models for interference prediction – Electromagnetic compatibility.

UNIT V: Standards and Laboratory Techniques 9 Hours

Industrial and government standards- FCC requirements- CISPR recommendations- laboratory techniques- measurement methods for field strength, EMI

Total no. of Hours: 45

References:

1. Berhard Keiser, "Principles of Electro-magnetic Compatability", Artech House, Inc., 2003.
2. Rickets,L.W., Bridges,L.E. and Milleta, J., "EMP Radiation and Protective Techniques", John Wiley and Sons, USA 1999.
3. IEEE National Symposiums on Electromagnetic compatibility, IEEE.
4. www.emf-emi.com

M.Tech –Power Electronics & Drives (Full Time)

MEE18PDE08 **EMBEDDED SYSTEM DESIGN** **3 0 0 3**

OBJECTIVES:

- Understand the concept of microcontrollers
- Ability in Embedded system programming
- Ability to design controller using embedded system.

UNIT I: 8051 Microcontrollers **9 Hours**

Embedded system concepts – Embedded Hardware devices – Introduction to 8051 microcontroller – 8051Derivatives - Architecture of 8051 microcontroller - Memory Organization - Addressing Modes - Assembly Language Instructions

UNIT II: Embedded System Programming **9 Hours**

Embedded Software Tools - Assembler - Compiler - Simulator – Debugger – In circuit Simulator – Integrated Development Environment (IDE) - Introduction to Embedded 'C' Programming - Programming in Embedded Controllers

UNIT III: Embedded Peripherals & Interfacing **9 Hours**

Embedded Peripherals - General Purpose I/O - Timer - Counter - UART/USART-Interrupts - ADC-DAC – Parallel Port - Peripheral Interfacing with input/output devices - LED-LCD – Keyboard - ADC - DAC

UNIT IV: RISC Embedded Controllers **9 Hours**

Comparison of CISC and RISC Controllers - Pipelining Architecture - Introduction to PIC Microcontrollers - PIC16F877 Architecture - Memory Organization - Addressing Modes - Assembly Language Instructions – Embedded C programming withPIC16F877

UNIT V: Distributed Embedded System Design **9 Hours**

Distributed Embedded System – Embedded Networking - RS232-RS485 - Inter-Integrated Circuit (I2 C) – Serial Peripheral Interface (SPI) - Universal Serial Bus (USB) - Controller Area Network (CAN) - Embedded Networking using Ethernet devices

Total no. of Hours: 45

References:

1. Kenneth J. Ayala, "The 8051 Microcontroller Architecture Programming & Applications".
2. MykePredko, "Programming & Customizing PIC Microcontrollers".
3. ZdravkoKarakehayov, "Embedded System Design with 8051 Microcontrollers".
4. www.raisonance.com
5. www.ccsinfo.com
6. www.micrchip.com
7. www.atmel.com

M.Tech –Power Electronics & Drives (Full Time)

MEE18EE11 ADVANCED MICROPROCESSOR AND MICROCONTROLLER DESIGN 3 0 0 3

OBJECTIVES:

- Understand the concept of microcomputers
- Study of various microcontrollers
- Familiarity in timing & trouble shouting in microcontrollers.

UNIT I: Computers, Microcomputers and Microprocessors 9 Hours

Types of computers, how computers and microcomputers are used, microcomputer structure and operation, execution of a three-instruction program, microprocessor evolution and types, the 8086 microprocessor family overview, 8086 internal architecture, introduction to programming the 8086

UNIT II: 8086 System Connections, Timing and Troubleshooting 9 Hours

A basic 8086 microcomputer system, addressing memory and ports in microcomputer Systems Microprocessors and microcontrollers, Z80 and the 8051, a microcontroller survey, development systems for microcontrollers

UNIT III: 8051 Architecture 9 Hours

8051 micro controller hardware, input/output pins, ports, ports and circuits, external memory, counters and timers, serial data I/O, interrupts. Moving data: Addressing modes, external data moves, code memory read PUSH and POP OPcodes, data exchanges. Logical operations: Byte-level logical operations bit –level logical operations, rotate and swap operations. Arithmetic operations: Flags, incrementing and decrementing, addition, subtraction, multiplication and division, decimal arithmetic. Jump and call instructions: Jump and call program range, jumps, calls and subroutines, interrupts and returns.

UNIT IV: An 8051 Microcontroller Design 9 Hours

Microcontroller specifications, 8051 micro controller design, testing the design, timing subroutines, look up tables for 8051, serial data transmission.

UNIT V: Applications 9 Hours

Keyboards, displays, pulse measurements, D/A and A/D conversions, multiple interrupts. Serial data communication: Network configuration, 8051 data communication modes. Introduction to other 16 bit, 32 bit microprocessors and microcontrollers: Intel 80x86, PIC, ARM etc families.

Total no. of Hours: 45

References:

1. D. V. Hall , Microprocessors& Interfacing – Programming & hardware (TMH)
2. Walter A. Trebel & Avtar Singh , The 8088 AND 8086 microprocessors (PHI)

MEE18PDE09 SWITCHED MODE AND RESONANT CONVERTERS 3 0 0 3

OBJECTIVES:

- Understands the principle of SMPS
- Ability to control SMPS
- Capable to model SMPS

UNIT I: SMPS Topologies 9 Hours

Buck, Boost, Buck-Boost SMPS Topologies, Basic Operation- Waveforms - modes of operation - switching stresses - switching and conduction losses - optimum switching frequency - practical voltage, current and power limits - design relations - voltage mode control principles. Push-Pull and Forward Converter Topologies - Basic Operation, Waveforms - Flux Imbalance Problem and Solutions - Transformer Design -Output Filter Design - Switching Stresses and Losses -Forward Converter Magnetics --Voltage Mode Control.

UNIT II: Control of SMPS 9 Hours

Voltage Mode Control of SMPS. Loop Gain and Stability Considerations. Shaping the Error Amp frequency Response, Error Amp Transfer Function, Transconductance Error Amps, Study of popular PWM Control ICs (SG 3525, TL 494, MC34060 etc) Current Mode Control of SMPS, Current Mode Control Advantages, Current Mode Vs Voltage Mode, Current Mode Deficiencies, Slope Compensation, Study of a typical Current Mode PWM Control IC UC3842

UNIT III: Modeling of SMPS 9 Hours

Modeling of SMPS, State Space Averaging and Linearisation, State Space Averaging Approximation for Continuity, Discontinuous Conduction Modes, Small Signal Approximation- General Second Order Linear Equivalent Circuits, The DC Transformer. Voltage Mode SMPS Transfer Function, General Control Law Considerations, Source to State Transfer Function, Source to Output Transfer Function, Stability, Loop Compensation EMI Generation and Filtering in SMPS - Conducted and Radiated Emission Mechanisms in SMPS Techniques to reduce Emissions, Control of Switching Loci, Shielding and Grounding, Power Circuit Layout for minimum EMI, EMI Filtering at Input and Output, Effect of EMI Filter on SMPS Control Dynamics

UNITIV: Resonant Converters 9 Hours

Introduction to Resonant Converters, Classification of Resonant Converters, Basic Resonant Circuit Concepts, Load Resonant Converter, Resonant Switch Converter, Zero Voltage Switching Clamped Voltage Topologies, Resonant DC Link Inverters with Zero Voltage Switching, High Frequency Link Integral Half Cycle Converter

UNIT V: Bridge Converters 9 Hours

Half and Full Bridge Converters, Basic Operation and Waveforms- Magnetic, Output Filter, Flux Imbalance, Switching Stresses and Losses, Power Limits, Voltage Mode Control. Fly back Converter- discontinuous mode operation, waveforms, Control, Magnetic- Switching Stresses and Losses, Disadvantages - Continuous Mode Operation, Waveforms, Control, Design Relations.

Total no. of Hours: 45

References:

1. Abraham I Pressman, Switching Power Supply Design, McGraw Hill Publishing Company.
2. Daniel M Mitchell: DC-DC Switching Regulator Analysis, McGraw Hill Publishing Company.
3. Ned Mohan et.al: Power Electronics, John Wiley and Sons.
4. Otmar Kilgenstein: Switched Mode Power Supplies in Practice, John Wiley and Sons.Supplies. Van Nostrand Reinhold, New York.

M.Tech –Power Electronics & Drives (Full Time)

MEE18PE17 **MICROGRID IN MODERN POWER SYSTEMS** **3 0 0 3**

OBJECTIVES:

- Development of Micro grid.
- Ability to understand the operation of SCADA
- Ability to design protection and control for microgrid

UNIT I: Distributed Generation and Micro grid Concept **9 Hours**

Distributed Generation-Active Distribution Network-Concept of Microgrid- Configuration-Interconnection of Microgrid-Technical and economical Advantage of Microgrid-Challenges and disadvantages of Microgrid Development- Management and Operational Issues of a Microgrid- Dynamic Interactions of Microgrid with main grid- Basics of Distributed Energy Resources.

UNIT II: Impacts of Micro grid and Active Distribution Management System **9 Hours**

Introduction- Impact of Heat Utilization- Impact on process Optimization-Impact on market-Impact on environment-Impact on Distribution System-Impact on communication standards and protocols-Network Management needs of Microgrid—Micro source Controller- Central Controller.

UNIT III: Protection Issues on Microgrid and Power Electronic Interface **9 Hours**

Introduction-Islanding: Separation from Utility-Major Protection issues of standalone Microgrid-Power Electronic Interface Introduction- Background- Power converter trends- Bricks-Buses-Software (BBS) framework- BBS Issues.

UNIT IV: SCADA & Distribution Networks, Impact of DG Integration on PQ **9 Hours**

Introduction- Existing DNO SCADA systems - Control of DNO SCADA systems- SCADA in Microgrid - Human–machine interface (HMI)- Hardware components - Communication trends in SCADA-Distributed control system (DCS)- Sub-station communication standardization - SCADA communication and control architecture - Communication devices- Observations on SCADA and communication - Introduction to Power quality Disturbances

UNIT V: Micro grid Economics and Market Participation **9 Hours**

Introduction- Micro grids and traditional power system economics- Joint optimization of heat and electric power supply- Emerging economic issues in Micro grids- Micro generation-Future developments of Microgrid economics. Restructuring models - Independent System Operator (ISO) - Power exchange (PX) - Market clearing price (MCP) - Day-ahead and hour-ahead markets - Elastic and inelastic markets- Market power stranded costs - Transmission pricing - Congestion management

Total no. of hours: 45

References:

1. S.Chowdhury., S.P.Choudhury., Microgrid & Active Distribution Networks (2009)ISBN 978-1-84919-014-5 The Institution of Engineering & Technology
2. Hector J. Altuve Ferrer, and Edmund O. Schweitzer III, (2010) Modern Solutions for Protection, Control and Monitoring of Electric Power Systems.
3. Fahd Hashiesh, M. M. Mansour, and Hossam E. Mostafa, (Feb 28, 2011) Wide Area Monitoring, Protection and Control: The Gateway to Smart Grids.
4. S.T.Rama, E.Sheeba Percis, A.Nalini, S.Bhuvaneswari (2017), Handbook on Standalone Renewable Energy Systems, Research India Publication, ISBN 978-93-87374-12-6
5. Zhaoyang Dong, Pei Zhang, Jian Ma, and Junhua Zhao, (May 21, 2010) Emerging Techniques in Power System Analysis.

M.Tech –Power Electronics & Drives (Full Time)

MEE18PE11 INTELLIGENT OPTIMIZATION TECHNIQUES AND APPICATIONS IN MODERN POWER SYSTEMS **3 0 0 3**

OBJECTIVES:

- Familiarity to evolutionary algorithm.
- Capable to solve Power System problem using optimization techniques.
- Capable to develop programming with suitable software.

UNIT I: Evolutionary Algorithm **12 Hours**

Introduction to Computational Intelligence – Genetic Algorithms – Initiation – Selection **-** Crossover **-** Mutation– Control Parameters – Genetic Algorithm Variants – Differential Evolution **-** Basic Differential Evolution – Basics of Cultural Algorithm.

UNIT II: Computational Swarm Intelligence **12 Hours**

Particle Swarm Optimization: Basic Particle Swarm Optimization **-**Global Best PSO-Local Best PSO **-** Ant colony Algorithms: Ant Colony Optimization **-**Foraging Behavior of Ants-Simple Ant Colony Optimization.

UNIT III: Application to Modern Power System **21 Hours**

Study of Power System Optimization Techniques like Optimal Capacitor Placement, Optimal Meter Placement, Optimal Location of DG, Power System Stabilizers etc

The students have to develop the suitable code with suitable software to apply the Intelligent Optimization Techniques in Unit I and II to the Application of Power System in Unit III.

Total no. of Hours: 45

References:

1. Andries P. Engel brecht, Computational intelligence, university of Pretoria-South Africa
2. Singiresu S. Rao, Engineering optimization. West Lafayette Indiana: