DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, UTTAR PRADESH, LUCKNOW

Syllabus

For

M.Tech.

POWER ELECTRONICS & DRIVES

1. **POWER ELECTRONICS,**
2. **ELECTRICAL DRIVES & CONTROL**

(Effective from the Session: 2016-17)

EVALUATION SCHEME FOR MTECH COURSES (POWER ELECTRONICS & DRIVES)

TO BE EFFECTIVE FROM SESSION 2016-17

SEMESTER-I

S.NO.	SUBJECT CODE	NAME OF THE SUBJECT	PERIODS			CREDIT	EVALUATION SCHEME					SUBJECT TOTAL
			L	T	P		THEORY			PRACTICAL		
							CT	TA	ESE	TA	ESE	
1	MTED-101	ELECTRIC DRIVES	3	0	0	3	20	10	70			100
2	MTED-102	POWER CONVERTER-I	3	0	0	3	20	10	70			100
3		DEPARTMENTAL ELECTIVE-I	3	0	0	3	20	10	70			100
4		DEPARTMENTAL ELECTIVE-II	3	0	0	3	20	10	70			100
5		RESEARCH PROCESS & METHODOLOGY	3	0	0	3	20	10	70			100
6	MTED-151	ELECTRIC DRIVES LAB			3	2				20	30	50
7	MTED-152	POWER CONVERTER LAB-I			2	1				20	30	50
	TOTAL					18						600

SEMESTER-II

S.NO.	SUBJECT CODE	NAME OF THE SUBJECT	PERIODS			CREDIT	EVALUATION SCHEME					SUBJECT TOTAL
			L	T	P		THEORY			PRACTICAL		
							CT	TA	ESE	TA	ESE	
1	MTED-201	POWER SEMICONDUCTOR CONTROLLED ELECTRIC DRIVE	3	0	0	3	20	10	70			100
2	MTED-202	POWER CONVERTER-II	3	0	0	3	20	10	70			100
3		DEPARTMENTAL ELECTIVE-III	3	0	0	3	20	10	70			100
4		DEPARTMENTAL ELECTIVE-IV	3	0	0	3	20	10	70			100
5		DEPARTMENTAL ELECTIVE-V	3	0	0	3	20	10	70			100
6	MTED-251	POWER CONVERTER LAB-II			3	2				20	30	50
7	MTED-252	SEMINAR-I			2	1				50		50
	TOTAL					18						600

SEMESTER-III

S.NO.	SUBJECT CODE	NAME OF THE SUBJECT	PERIODS			CREDIT	EVALUATION SCHEME					SUBJECT TOTAL
			L	T	P		THEORY			PRACTICAL		
							CT	TA	ESE	TA	ESE	
1	MTED-351	SEMINAR-II	0	0	6	3				100		100
2	MTED-352	DISSERTATION	0	0	30	15				200	300	500
	TOTAL											600

SEMESTER-IV

S.NO.	SUBJECT CODE	NAME OF THE SUBJECT	PERIODS			CREDIT	EVALUATION SCHEME					SUBJECT TOTAL
			L	T	P		THEORY			PRACTICAL		
							CT	TA	ESE	TA	ESE	
1	MTED-451	DISSERTATION(FINAL)	0	0	36	18				200	400	600
	TOTAL					18						600

EVALUATION SCHEME FOR MTECH COURSES (POWER ELECTRONICS & DRIVES)
TO BE EFFECTIVE FROM SESSION 2016-17

CODE	ELECTIVE-I
MTPS-012	ADVANCED CONTROL SYSTEM
MTEE-012	DIGITAL SIGNAL PROCESSING
MTED-011	NEURAL NETWORKS & FUZZY SYSTEM
	ELECTIVE-II
MTED-021	POWER SEMICONDUCTOR DEVICES
MTED-022	WIND & SOLAR BASED ENERGY CONVERSION SYSTEMS
MTPS-021	ADVANCED MICROPROCESSORS & ITS APPLICATIONS
	ELECTIVE-III
MTED-031	POWER CONVERTER APPLICATIONS
MTED-032	NON CONVENTIONAL ENERGY SOURCES & ENERGY CONVERTERS
MTEE-032	DIGITAL CONTROL SYSTEMS
	ELECTIVE-IV
MTED-041	FACTS
MTED-042	HVDC TRANSMISSION SYSTEMS
MTEE-042	MODELING & SIMULATION OF POWER ELECTRONIC SYSTEMS
	ELECTIVE-V
MTED-051	MECHATRONIC SYSTEMS
MTEE-052	POWER QUALITY
MTEE-053	OPTIMIZATION TECHNIQUES

I YEAR (I SEMESTER)

MTED-101 ELECTRIC DRIVES

L T P
3 0 0

Introduction:
Basic drive components, classification and operating modes of electric drive, nature and types of mechanical loads, review of speed-torque characteristics of electric motor and load, joint speed torque characteristics

Electric Braking
Plugging, dynamic and regenerative braking of dc and ac motors

Dynamics of Electric Drive System:
Equation of motion, equivalent system of motor-load combination, stability considerations, electro-mechanical transients during starting and braking, calculation of time and energy losses, optimum frequency of starting.

Traction Drive:
Electric traction services, duty cycle of traction drive, calculation of drive rating and energy consumption, desirable characteristic of traction drive and suitability of electric motors, control of traction drive.

Energy conservation in Electric Drive:
Losses in electric drive system and their minimization energy, efficient operation of drives. Load equalization.

Estimation of Motor Power Rating:
Heating and cooling of electric motors, load diagrams, classes of duty, reference to Indian standards, estimation of rating of electric motors for continuous, short time and intermittent rating.

Special Electric Drive:
Servo motor drive, step motor drive, linear induction motor drive, permanent magnet motor drive.

Selection of electric drive:
Selection criteria of electric drive for industrial application, case studies related to steel mills, paper mills, textile mills and machine tool etc.

Reference:

1. G.K. Dubey, “Fundamentals of Electric Drive” Narosa Publishing House 1995
2. M.Chilkin, “Electric Drive”, Mir Publishing.
3. S.K. Pillai “A First course on Electric Drive” New Age International Publishers, 1981.
4. N.K. De and P.K. Sen, “Electric Drive,” Prentice Hall of India, 1999
5. Vedam Subrahmanyam, “Electric Drive: Concepts and Applications” Tata McGraw Hill, 1994

MTED-102 POWER CONVERTERS-I

L T P
3 0 0

1. **Power Semiconductor Devices:**
   Structure, Characteristics, ratings and protection of SCR, triac and Gate Turn Off thyristor.
2. **Line Commutated Converters:**
   Single and three phase Fully controlled and half controlled converters, performance characteristics, effect of source inductance, discontinuous current operation, inverter operation, power factor improvement techniques, sequence control, 12-pulse converters, dual converter, triggering circuit.
3. **AC Voltage Controllers:**
   Single phase ac voltage controller feeding resistive and resistive-inductive loads sequence control, three phase ac voltage controllers.
4. **Cyclo-Converter:**
   Single phase and three phase Cyclo-converters, circulation and non-circulating current operations, performance characteristics, control of harmonics, voltage and frequency control, control circuit

Reference:

1. M.H. Rashid, “Power Electronics: Circuits, Devices and Application”, Prentice Hall of India, 1996
2. N. Mohan, T.M. Undeland and W.P.Robbins, “Power Converters, Applications and Design”, John Wiley & Sons, 1995.
3. G.K. Bubey et al, Thyristorized Power Controllers”, Wiley Eastern, 1987
4. B.R., Pelly, “Thyristor Phase Controlled Converters and Cyclo-Converters” Wiley Interscience, 1971.
5. M.d. Singh and K.B Khanchandani “Power Electronic Tata McGraw Hil, 2001
6. V. Subrahmanyam, “Power Electronics”, New Age International Publishers, 1997.

ELECTIVE -I

MTPS-012 ADVANCED CONTROL SYSTEM

L T P
3 0 0

Objective & Outcome of learning

This course will help students to learn about the state space analysis applied to control system using matrices and different methods of analyzing nonlinear as well as discrete control systems. The course also introduces to the students the basic concepts of optimal, adaptive and robust control systems. At the end of the course the students shall be able to handle different control system problems in nonlinear as well as discrete domain.

1. States Space Analysis:

Review of the state space representation of continuous linear time invariant system, conversion of state variable models to transfer functions and vise-versa, transformation of state variable, solution of state equations, state and output controllability and observability.

2. Analysis of Nonlinear Systems:

Common physical non linearites , singular points, phase plane analysis, limit cycle, describing function method and stability analysis, jump resonance, linearization of nonlinear system. Lyapunov stability , methods for generating Lyapunov function , statement of lure problem, circle criterion, Popov criterion.

3. Analysis of Discrete System:

Discrete time signals and systems, z-transformation, modeling of sample hold circuit, pulse transfer function, solution of difference equation by z-transform method , stability analysis in z-plane.

4. Basic concepts of optimal control, adaptive control and robust control system.

References:

1. K.Ogata, “Modern Control Engineering”, Prentice Hall of India , 1999
2. Norman S.Nise, “Control System Engineering”, John Wiley & Sons, 2001
3. Kuo B.C., “Digital Control System”, Saunders College publishing, 1992
4. M.Gopal , “Digital Control and state variable methods”, Tata Mc graw Hill, 1997
5. M.Gopal , “Modern Control System Theory”, Wiley Eastern, 1993
6. K.Ogata, “ Discrete Time Control System”, Prentice Hall International, 1987.

Related Journals and Books for applications and advanced works.

(i) IEEE Transactions on Control System Technology
(ii) IET Research Journal on Control Theory & Applications
(iii) NPTEL Courses on Electrical Engineering

MTEE-012 DIGITAL SIGNAL PROCESSING

L T P
3 0 0

Objective & Outcome of learning
This course will make students conversant with the designing of analog and digital FIR filters using various digital signal processing techniques. At the end of the course the students will be able to design and analyze digital filters**.**

1. Introduction:
Motivation, advantages and applications of digital signal processing, review of A/D and D/A conversion, quantization noise.

2. Discrete Time Signals and Systems:
Representation of discrete signals, linear time invariant system, FIR and HR system, stability and causality of the systems, systems described by difference equations, solution of difference equations

3. Realization of Digital Systems:
Block diagram and signal flow representations, matrix representation, direct, cascade, parallel, lattice and ladder realization of HR systems, direct, cascade and lattice realization of FIR systems.

4. Fast Fourier Transform:
Introduction to discrete Fourier transform and fast Fourier transform, circular and linear convolutions ,FFT algorithms, Radix-2 , Radix-4 and split radix algorithms, applications of FFT algorithms.

5. FIR Digital Filter Design:
Properties of linear phase FIR filter, frequency sampling design techniques, window design techniques (Uniform window, Hamming window, kaisc window), optimal FIR filter design.

6 . FIR Filter Design
Characteristics of proto type analog filter, comparison of HR and FIR filters, impulse invariant transformation and bilinear transformation, design of digital, Butterworth, chebyshev and elliptic filters, introduction to digital signal processor

Reference:
1. A.V. Openheim and R.W. Schafev, “Discrete Time Signal Processing”, Prentice Hall Englewood Cliffs, N.J. 1975
2. J.G. Proakis and D.G. Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, Prentice Hall of India
3. L.R. Rabiner and B. Gold, “Theory and Applications of Digital Signal Processing”, Prentice Hall Englewood cliffs, nj 1975
4. Vinay K. Ingle & John G. Proakis, “Digital Signal Processing UsingMatlab”, Thomson Asia Pvt. Ltd.
5. Sanjit K. Mitra, “Digital Signal Processing”,Tata Mcgraw Hill 2001

Related Journals and Books for applications and advanced works.
(i) IEEE Transactions on digital signal processing
(ii) IEEE Transactions on Power Electronics
(iii) IEEE Transactions on Automatic control
(iv) NPTEL Courses on Electrical Engineering

MTED-011 NEURAL NETWORKS AND FUZZY SYSTEM

L	T	P
3	0	0

A. Neural Networks :

1. Basics :

Simple neuron, nerve structure and synapse, concept of neural network multilayer nets, auto-associative and hetero-associative nets, neural network tools (NNTs), artificial neural network (ANN) and traditional computers.

2. Neural Dynamics :

Neurons as functions, neuronal dynamic systems, signal functions, activation models

3. Synaptic Dynamics :

Learning in neural nets, Unsupervised and supervised learning, signal hebbian learning competitive learning, differential hebbian learning, differential competitive learning single layer perception models, the back propagation algorithm.

4 Applications :

Applications in load flow study, load forecasting detection of faults in distribution system and steady state stability, neural network simulator, applications in electric drive control.

B. Fuzzy System :

5. Basics :

Fuzzy sets and systems, basic concepts, fuzzy sets and crisp sets, fuzzy set theory and operations, fuzzy entropy theorem, fuzzy and crisp relations, fuzzy to crisp conversions.

6. Fuzzy Associative Memories :

Representation of fuzzy sets, membership functions, basic principle of interference in fuzzy logic, fuzzy IF-THEN rules, fuzzy systems and algorithms, approximate reasoning, forms of fuzzy implication, fuzzy inference engines, fuzzification/defuzzification

7. Applications :

Fuzzy control system design and its elements, fuzzy logic controller applications of fuzzy control in electric drive, power system, measurement and instrumentation.

References :

1. Bart Kosko, “Neural Networks fuzzy systems”, Prentice Hall International
2. George J. Klin, & Tina A. Polger, “Fuzzy Sets, uncertainty and Information”,
3. Russel C. Ebehart Roy W. Dobbins, “Neural Network PC tools”, Academic press Inc.
4. Martin T. Hagan, H.B. “Neural Network design”, Thomson Demuth Mark Beate, Asia Pvt Ltd.
5. Simon Haykin “Neural Network and Learning machines” Third Edition, PHI learning, new Delhi,2011.
6. J.R. Jang, C. Sun and E. Mizuatani, “Neuro-fuzzy Soft computing: A Computational Approach to learning and Machine Intelligence.” PHI, 2011.

ELECTIVE-II

MTED-021 POWER SEMICONDUCTOR DEVICES

L T P
3 0 0

Objective & Outcome of learning

This course imparts a thorough knowledge to students regarding structure, characteristics, protection and drive circuits of power diodes, power transistors, MOSFET, Thyristors, GTO, IGBT, Triacs etc. At the end of the course the students shall be able to work with these devices.

Details of experiments: Experiments based on characteristics of various power electronic devices and performance of various converters using these devices.

1. Introduction:

General overview of power semiconductor devices and their desirable characteristics. Comparison of power semiconductor devices.

2. Power Diodes:

General purpose diode, fast recovery diode schottky diode, diode snubbers.

3. Power Bipolar Junction Transistors:

Physical structure and device operation , static V-I and switching characteristics, secondary breakdown and safe operating area, snubber circuits , base drive control.

4. Power MOSFETS:

Physical structure and device operation, static V-I and switching characteristics, operating limitations and safe operating area, gate series and snubber circuits.

5. Thyristors:

Physical structure and device operation, two transistor analogy, static V-I and switching characteristics , age characteristics , firing circuits, snubber circuits series and parallel operation

6. GTO(Gate Turn Off) Thyristors:

Physical structure and device operation, static V-I and switching characteristics, drive and snubber circuits

7. Insulated Gate Bipolar Transistors:

Physical structure and device operation, static V-I and switching characteristics, safe operating area , drive and snubber , circuit.

8. Special Power Devices:

Physical structure, device operation and static V-I characteristics of reverse conducting thyristor , field controlled Thyristors , MOS controlled Thyristors

9. Triacs:

Physical structure and device operation

Reference:

1. B. Jayant Baliga, “Modern Power Drives”, John Willey & Sons 1987
2. N. Mohari, T.M. Undeland and W.P. Robbins, “Power Electronics Converters Applications and Design”,John Willey & Sons 1995
3. M.H. Rashid, “Power Electronics Circuit Devices and Applications”, Prentice Hall of India 1996
4. Dubey G.K. et al, “Thyristorised Power Controllers”, Willey Eastern Limited 1987
5. M.D. Singh and K.B. Khanchandani, “Power Electronics”, TataMcGraw Hill 2001
6. John G. Kassakian, Martin F. Schleht and G.C. Varghese, “Principles of Power Electronics”, Addison Wesley publishing co 1991.

Related Journals and Books for applications and advanced works.

(i) IEEE Transactions on Industrial applications
(ii) IEEE Transactions on Power Electronics
(iii) IEEE Transactions on Electronics Devices
(iv) IET Research Journal on Power Electronics
(v) NPTEL Courses on Electrical Engineering

MTED-022 WIND & SOLAR BASED ENERGY CONVERSION SYSTEMS

L	T	P
3	0	0

1.INTRODUCTION

trends in energy consumption-world energy scenario, energy resources and their availability, conventional and renewable sources, need to development new energy technologies

2.PHOTOVOLTAIC ENERGY CONVERSION

solar radiation and measurement, solar cell and their characteristics ,influence of insulation and temperature, PV arrays, electrical storage with batteries, solar availability ,switching devices for solar energy conversion ,maximum power point tracking

3. POWER CONDITIONING SCHEMES

DC power conditioning converters,MPPT algorithm , AC power conditioners, line commuted inverters, synchronised operation with grid supply, harmonic problem.

4. PV APPLICATIONS & WIND ENERGY SYSTEMS

stand alone inverters, charge controllers, water pumping, audio visual equipments, street lightning, analysis of PV systems.

5. WIND ENERGY SYSTEMS

basic principle of wind energy conversion, nature of wind, wind survey in India, power in the wind, components of wind energy conversion system, performance of induction generators for WECS
,classification of WECS, self excited induction generator for isolated power generators, theory of self excitation, capacitance requirements, power conditioning schemes, controllable DC power form SEIGs, system performance, grid connecters concepts , wind farm and its accessories, grid related problems, generator control, performance improvements, different schemes, AC voltage controllers, harmonics and PF improvements.

REFRENCES:

1. Mukund R Patel,"Wind and Solar Power Systems", CRC press , 2004
2. Rai G D ,"Wind Power Energy Resources", Khanna Publishers New Delhi 2002
3. Daniel Hunt V," Wind Power - A Hand Book of WECS", VAN NOSTREND CO.
4. Thomas Markvart and Luis Castaser," Practical Hand Book of Photovoltaic"S Elsevier Publications , UK ,2003

MTPS-021 ADVANCED MICROPROCESSORS AND APPLICATIONS

L T P
3 0 0

Introduction:
Review of basic microprocessor, architecture and instruction set of typical 8 bit microprocessor

Advanced Microprocessor:
Overview of 16 bit and 32 bit microprocessors, arithmetic and I/O coprocessors, architecture, register details, operation addressing models and instruction set of a 16 bit 8086 microprocessor, assembly language programming, introduction to multiprocessing, multiuser, multitasking operating system concepts, Pentium I, II, III, IV processors, Motorola 68000 processor

Input-Output Interfacing:
Parallel an series I/O, programmed I/O, Interrupt driven I/O, single and multi interrupt levels, use of software polling and interrupt controlling for multiplying interrupt levels, programmable interrupt controller, DMA controller programmable timer/counter, programmable communication and principal interface, synchronous and asynchronous data transfers, standard serial interfaces like Rs.232.

Programmable Support Chips:
Functional schematic, operating modes, programming and interfacing of 8255, 8251, 8259 and 8253 with microprocessor.

Memory Interfacing:
Types of Memory: RAM and ROM, interfacing with timing consideration DRAM interfacing

Analog Input & Output:
Microprocessor compatible ADC and DAC chips, interfacing of ADC and DAC with microprocessor, use of sample and hold circuit and multiplexer with ADC.

Micro-controller and Micro-Computer:
Concepts of micro controller and micro computer micro controller (8051/8759) based design. Application of micro computer in online real time control

Microprocessor Development System (MDS):
Single user, time shared and networked MOS, hardware facilities and software support in MDS, development of hardware and application software and hardware software integration in MDS.

Microprocessor Application:
Design methodology, examples of microprocessor applications.

Reference:

1. R.S. Gaonkar, “Microprocessor Architecture, Programming and Application,” Wiley Eastern Limited.
2. B.Ram, “Fundamentals Of Microprocessors and Micro computers,” Dhanpat Rai and Sons.
3. Liu & Gibson, “Micro-Computer System the 8086/8088 family architecture,” Prentics Hall of India.
4. D.V. Hall, “Microprocessors and Interfacing Programming and Software,” McGraw Hill

MTED-151 ELECTRIC DRIVES LABORATORY

L T P
0 0 3

Torque-speed c/s of a separately excited DC motor drive fed by a two-pulse centre-tapped thyristor rectifier and 6-pulse fully controlled rectifier - Study of a four-quadrant separately excited DC motor driveImplementation of centre spaced space vector modulation with DSP - TMS320LF2407 for V/Hz control of induction motor drives - Implementation of discontinuous space vector modulation with DSP - TMS320LF2407 for V/Hz control of induction motor drives.

I YEAR (II SEMESTER)

MTED-201 POWER SEMICONDUCTOR CONTROLLED ELECTRIC DRIVES

L T P
3 0 0

Objective & Outcome of learning

This course will impart knowledge to the students regarding the different control schemes used for the controlling of DC and AC drives and the implementation of these schemes of DC and AC drives using microprocessor. At the end of the course the students will be able to work with these drives in industries.

Details of experiments:

Experiments based on the performance evaluation of various AC & DC drives to be carried out.

1. Introduction :

Solid state controlled electric drive – concept, elements and salient features; power converter motor system, closed loop control of electric drives, sensing of speed and current, performance parameters.

2. Control of D.C. Drives:

Control of d.c. separately and series excited motor drives using controlled converters (single phase and three phase)Choppers Static ward Leonard control scheme Solid state electric braking schemes Closed loop control of solid state dc drives.

3. Control of A.C. motor drives:

Operation of induction and synchronous motor drives from voltage source and current source inverters, slip power recovery, pump drives using ac line controllers, self controlled synchronous motor drive, vector control of induction and synchronous motor drives, closed loop schemes, brushless dc motor drive, switched reluctance motor drive.

4. Microprocessor Control of Electric Drive :

Functions of microprocessor in electric drive control, salient features of microprocessor control, microprocessor based control schemes for d.c., induction and synchronous motor drives, applications.

Reference:

1. G.K. Dubey, “Fundamentals of Electric Drives”, 2nd edition, Narosa publishing House.
2. G.K. Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall, New Jersey
3. S.B. Dewan, G.R. slemon, a. Sraughen, “Power Semiconductor Drives”, John Willey & sons
4. M.D.Singh, K.B.Khanchandani, “Power Electronics”,TataMcgraw-Hill, New Delhi
5. Bimal Kumar Bose, “Modern Power Electronics and AC Drives”, Pearson Education

Related Journals and Books for applications and advanced works.

(i) IEEE Transactions on Industrial applications
(ii) IEEE Transactions on Power Electronics
(iii) IEEE Transactions on Power Delivery
(iv) IEEE Transactions on Power Electronics
(v) NPTEL Courses on Electrical Engineering
(vi) IET Research Journal on Power Electronics

MTED-202 POWER CONVERTER -II

L T P
3 0 0

Objective & Outcome of learning

This course imparts knowledge to the students regarding hard switched power electronic devices such as power transistor, MOSFET, IGBT etc. The course also make students fully conversant with the dc-dc converters and inverters using these devices. At the end of the course the students shall be able to design dc-dc converters and inverters using hard switched devices.

1. Power Semiconductor Devices :

Structure, characteristics and ratings of Power Transistor, MOSFET, Insulated Gate Bipolar Transistor (IGBT) and MOS – Controlled Thyristors (MCT); drive and Snubber circuits.

2. DC – DC Converters:

Review of chopper fundamentals, step down chopper with resistive and resistive – inductive loads with continuous and discontinuous current operations, step up chopper, commutation techniques, impulse commutated and resonant pulse chopper, multiquadrant and multiphase choppers.

Switching mode regulators: Buck, Boost, Buck – Boost, Cuk and fly back regulators.

3. DC – AC Inverters:

Single phase and three phase voltage source and current source inverters, commutation methods, voltage and frequency control, harmonic reductions.

4. Resonant Inverters :

Classification, series and parallel resonant inverters, load resonant inverters, zero voltage switching and zero current switching resonant inverters, resonant dc link inverters.

Reference:

1. M.H. Rashid, “Power Electronics: circuits, Devices and Applications”, Prentice Hall India, 1996.
2. N.Mohan, T.M. Undeland and W.P. Robbins, “Power Converters, Applications and Design”, John Wily & Sons, 1995.
3. M.D. Singh and K.B. Khanchandani, “Power Electronics”, TataMcgraw Hill,2001.
4. D.W. Hart, “Introduction to Power Electronics”, Prentice Hall International, 1977.

Related Journals and Booksfor applications and advanced works.

(i) IEEE Transactions on Industrial applications
(ii) IEEE Transactions on Power Electronics
(iii) NPTEL Courses on Electrical Engineering
(iv) IEEE Transactions onElectron Devices
(v) IET Research Journal on Power Electronics

MTED-251 POWER CONVERTER LAB-II

L T P
0 0 3

Experiments and computer simulations on:

1. Single phase, three phase Semi converters and Full converters,
2. DC-DC Choppers using SCRs and Self communicating Devices.
3. Single phase and three phase inverters using IGBTs,
4. AC-AC voltage regulators.
5. DC and AC drives

ELECTIVE-III

MTED-031 POWER CONVERTER APPLICATIONS

L T P
3 0 0

1. Electric Utility Applications:

(a) HVDC Transmission: Schematic diagram, modes of operation, control characteristics, twelve pulse converters, converter faults and protection, harmonic filters and power factor correction capacitors.
(b) Static VAR Control: Concept of static VAR control, Thyristors controlled VAR compensation techniques, series compensation, synchronous link converter based VAR compensation, unified power flow controller (UPFC).
(c) Interconnection of Renewable Energy Sources to the Utility Grid: Photo voltaic array interconnection, wind and small hydro interconnections.

2. Industrial Applications:
Concept of resistance and induction heating, high frequency inverters for induction heating, ac voltage controllers for resistance heating and illumination control, electric welding control.

3. Power Supplies:
Switched mode dc power supplies, UPS, aircraft power supplies.

4. Power Generation:
Excitation control of synchronous generators.

Reference:

1. N. Mohan, T.M.Undeland and W.P. Robbins, “Power Electronics Converters, Applications and design”, John Wiley and Sons, 1995.
2. M.H. Rashid, “Power Electronics Circuits, Devices and Applications”, Prentice Hall of India, 1996.
3. E.W. Kimbark, “Direct current Transmission”, Vol-I, Wiley Inter science, 1982.
4. T.J. Miller, “Reactive Power Control in Electric System”, Wiley Interscience.

MTED-032

NON CONVENTIONAL ENERGY SOURCES & ENERGY CONVERTERS

L T P
3 0 0

Objective & Out come of learning.

This course is designed for the development of self study and seminar delivery skills in Non-conventional Energy Sources. The total course structure covers wind energy, Solar Energy and Fuel Cell Technologies. Subparts of each topic will be allotted to each student who will then deliver the talk during scheduled lecture hours to be evaluated by participants & the teacher.

1. Introduction:

Various non-conventional energy resources-importance, classification, relative merits and demerits

2. Solar Energy:

Solar photovoltaic's: Introduction, solar radiation & its relation with photovoltaic effect. Solar cell material; silicon mono & poly crystalline, raw material other than silicon. Different types of solar cell construction and design, flat plate arrays:-optimal system sizing & protection. Photovoltaic concentration, photovoltaic systems-standalone, PV-hybrid, grid-interactive. Stationary and tracking panels, maximum power point tracking, energy storage, converter & inverter systems & their control. Application-water pumping & power plants, cost & economics, recent developments.

3.Solar thermal:

Thermal characteristics of solar radiation, solar collectors:-materials, types, focusing. Solar thermal power plant-layout and arrangement, solar cooling, recent Developments.

4. Wind Energy:

Wind power and its sources, site selection criterion, wind characteristics, momentum theory, Classification of wind machines. Wind mills-different design & their control, wind generators-different types, wind farms & grid. Wind generation in India. Issues of wind integrations-intermittent supply, economics, governmental regulations & subsidies. Wind penetration & its effects, economic issues, recent developments, international scenario.

5. Fuel Cell:

Basic construction & principle of operation of fuel cell, Gibbs-Helmholtz equations, thermodynamic free energy and conditions of equilibrium, classification of fuel cell, different types of fuel cell:-direct type-low or medium temperature alkaline type, low temperature ion exchange membrance, direct high temperature fuel cells, Redox fuel cells, operation characteristic. Fuel cell power plants & its integration with wind and solar photovoltaic systems, smart grids.

References;

1. F.C. Treble, “Generating electricity from sun”, pergamon press, U K
2. Tapan Bhattacharya, “Terrestrial solar photovoltaics”, Narosa publishing house, New Delhi, 1998.
3. G.D. Rai, “Non-conventional energy resources”, Khanna Publishers, New Delhi, 2003.
4. S.P. Sukhatme, “Solar energy principles of thermal collection and storage”,McGraw-Hill publishing company, limited, New Delhi, 1984.
5. C.J. Winter, L.C. Sizmann and Van-Hull, “Solar power plants”, Sringer-Verlog publishers, 1991.
6. N.G. Clavert, “Wind Power Principle, their application on small scale”, Calvert Technical Press edition, published 2004.
7. “Fuel Cell Handbook” (Fifth Edition) by EG&G Services, Parsons, Inc. Science Applications International Corporation.
8. I Earnest and T. Wizelius “Wind Power Plants and Projects development” PHI, 2010.

Related e-Journals and books for advanced work.

(i) IEEE Transactions on Power Delivery
(ii) IEEE Transactions on Power System
(iii) IEEE Transactions on Energy Conversion
(iv) IET Research Journal on Renewable Power Generation.
(v) NPTEL Courses on Electrical Engg.

MTEE-032 DIGITAL CONTROL SYSTEM

L	T	P
3	0	0

Objective & Outcome of learning

This course imparts knowledge to students about application of digital signal processing and state space analysis in designing of digital control systems and analyzing the stability of digital control systems using various techniques. At the end of the course the students will be able to design and analyze the stability of digital control systems.

1. Signal Processing in Digital Control:

Basic digital control system, advantages of digital control and implementation problems, basic discrete time signals, Z – transform and inverse Z- transform, modeling of sample hold circuit, pulse transfer function, solution of difference equation by Z- transform method, stability on the z-plane and jury stability criterion, bilinear transformation, Routh Stability Criterion on plane.

2. Design of Digital Control Algorithms:

Steady state accuracy, transient response and frequency response specifications, digital compensator design usingfrequencyresponse plots androot locus plots.

3. State Space Analysis and Design:

State space representation of digital control system, conversion of state variable models to transfer functions and vice versa, solution of state difference equations, controllability and absorbability, design control system with state feedback, stability analysis using Lyapunov stability theorem, optimal digital control system.

Reference:

1. B.C. Kuo, “Digital Control System”, Saunders college publishing 1992
2. K.Ogata, “Discrete Time Control System”, Prentice Hall 1987
3. C.L. Philips and T. Nagle, “Digital Control System Analysis and Design”, Prentice Hall 1990
4. M.Gopal, “Digital Control and State VariableMethods”,TMH 1997
5. J.R leigh, “Applied Digital Control”, Prentice Hall 1985
6. C.H. Houpis and G.B. Lamont, “Digital Control System Theory Hardware & Software”, Mcgraw Hill 1992

Related Journals and Booksfor applications and advanced works.

(i) IEEE Transactions on Control SystemTechnology
(ii) IEEE Transactions on Automatic Control
(iii) IEEE Transactions on Embedded System
(iv) IET Journal on ControlTheory & Applications
(v) NPTEL Courses on Electrical Engineering

ELECTIVE-IV

MTED-041 FACTS

L T P
3 0 0

Objective & Outcome of learning

To impart advanced knowledge about the FACTS – systems involving their applications in long Bulk power Transmission line, in distribution systems, in custom Power and improving stability & voltage profile in power system. This is a new technology which has found acceptance in Power Industry. At the end of the course the student should be able to design power and distribution system using various FACT devices.

1. Basic Issues Involved in Bulk Power Transmission:

Angle stability, voltage stability, power flow control and sub-synchronous resonance (SSR).

2. Basic Issues Involved in Power distribution Systems:

Harmonics, load unbalance, poor powerfactor and voltage interruptions.

3. Introduction of Basic FACTS devices:

SVC, STATCOM,TCSC, SSSC and UPFC. Introduction to concepts of Custom Power (CP) devices

4. Introduction to CP devices:

DSTATCOM, DVR, UPQC. Modeling of SVC, STATCOM,TCSC, SSSC and UPFC.

5. Case Study

DSTATCOM in Current Control Mode:Reference current generation techniques.
DSTATCOM in voltage control Mode: Reference voltage generation, DVRreference voltage generation.

References:

1. N.G. Hingirani and L.Gyugi, Understanding FACTS, IEEE Press, 1999.
2. Y.H. Song and A.T. Johns, “Flexible AC Transmission Systems (FACTS), IEEE, 1999.
3. M.H.J. Bollen, “ Understanding Power Quality Problems:, IEEE Press, 2000.
4. R.c. dugan, M.F. Mc Granaghan and H.W. Beaty, “Electric Power Systems Quality”, Mc Graw Hill, 1996.
5. K.R. Padiyar, “FACTS controllers in Power Transmission and Distribution”, New Age, New Delhi, 2007.

Related Journals and Books for applications and advanced works.

(i) IEEE Transactions on Industrial applications
(ii) IEEE Transactions on Power Electronics
(iii) IEEE Transactions on Power Delivery
(iv) MATLABTools on Control and power system
(v) NPTEL Courses on Electrical Engineering
(vi) IET Research Journal on Power Electronics
(vii) IET Research Journal on Generation, Transmission and Distribution.

MTED-042 HVDC TRANSMISSION SYSTEMS

L T P
3 0 0

Objective & Outcome of learning.
To provide an in-depth understanding of the different aspects of D.C. Transmission system design and Analysis. At the end student will be able to design commercial transmission systems.

1.Rectification:
The 3-phase Bridge rectifier or Graetz circuit, Inversion, Kinds of D.C links, Paralleled and Series connection of thyristors, Power flow in HVDC transmission system.

2.Converter Station:
Major components of a converter station-converter unit, filters, reactive power source. Ground return and ground electrode.

3.Basic principles of DC link control:
Converter control characteristics, firing angle control and extinction angle control. Parallel operation of D.C. link with A.C. transmission line. Introduction to Multiterminal HVDC Systems and HVDC Circuit Breakers, Comparison between AC and DC transmissions, break even distance for overhead transmission lines and underground cables. Application of HVDC transmission.

Text books
1. K.R. Padiyar, "HVDC Power Transmission System", Second revised Edition, New Age Int. 2012
2. E.W. Kimbark. EHV-AC and HVDC Transmission Engineering & Practice, Khanna Publishers.
3. Arrillaga J "High Voltage Direct current Transmission" 2nd Edition (London) Peter Peregrinus, IEE, 1998.

Related e-Journals & books: for advanced work.
(i) IEEE Transmissions on Power Delivery
(ii) IEEE Transmission on Power System
(iii) IET Research Journal on Generation Transmission and Distribution
(iv) NPTEL Course on Electrical Engineering.

MTEE-042 MODELING AND SIMULATION OF POWER ELECTRONIC CIRCUITS

L T P
3 0 0

Objective & Outcome of learning

This course will make students conversant with the modeling and simulations of various power electronic devices and converters using simulation softwares like PSICE and MATLAB simulink. At the end of the course the students will be able to simulate power electronic converters and analyze their performance on computer, which will help in selecting the specifications of various components for fabricating the actual systems.

1. Simulation tools:

General overview and understanding of SPICE/PSPICE and MATLAB SIMULINK softwares.

2. Modeling of power electronics devices:

Criteria for switch selection , modeling of Diode , SCR , Power transistor MOSFET AND IGBT for ac and dc circuit using SPICE /PSPICE and MATLAB SIMULINK software, simulation of driver and snubber circuits.

3. Simulation of power electronics circuits:

Simulation and design of converters, Choppers, A.C. Voltage Controllers ,Inverters and Cyclo-converters

Reference:

1. M.H. Rashid " Power Electronics Circuit Devices and Applications", Prentice Hall of India 1996
2. D.W. Hart, "An Introduction to Power Electronics", Prentice Hall International , 1997
3. L.P. Huelsman, "Basic Circuit Theory", Prentice Hall of India 1995
4. The Mathworks Inc., "MAT LAB the Language of Technical Computing", version 6
5. The Mathworks Inc., "SIMULINK Dynamic System Simulation"

Related Journals and Books for applications and advanced works.

(i) IEEE Transactions on Industrial applications
(ii) IEEE Transactions on Power Electronics
(iii) IEEE Transactions on Power Delivery
(iv) MATLAB Tools on Control and power system
(v) NPTEL Courses on Electrical Engineering
(vi) IET Research Journal on Power Electronics

ELECTIVE-V

MTED-051 MECHATRONIC SYSTEMS

L T P
3 0 0

Unit 1. Electrical Systems
Mathematical modelling of Electro Mechanical Systems, RLC Circuits, active and passive electrical circuits, PMDC Motor, Stepper motor, three phase squirrel cage induction motor, three phase permanent magnet synchronous motor, servo motor.

2. Mechanical Systems
Introduction to various systems of units, mathematical modeling of mechanical systems, Newton's laws, moment of inertia, forced response and natural response, rotational systems, spring mass system, free vibration, spring mass damper system, mechanical systems with dry friction, work energy and power, passive elements and active elements an energy method for deriving equations of motion, energy and power transformers.

3. Fluid and Thermal systems
Mathematical modeling of liquid level system: Resistance and capacitance of liquid level systems with interaction. Mathematical modeling of pneumatic systems: Resistance and capacitance of pneumatic systems, mathematical modeling of a pneumatic systems, liberalization of non-linear systems. Mathematical modeling of hydraulic systems: Hydraulic circuits, hydraulic servo-meter and mathematical model of hydraulic servo motor dashpots. Mathematical modeling of thermal systems: Thermal resistance and 7 thermal capacitance mathematical modeling of thermal systems.

4. Design of Mechanical Elements
The phases of design, Design considerations, codes and standards, optimum design process, design variables, cost functions, design constraints, optimum design. Springs, rolling contact bearing, journal bearing, Spur and helical gear, bevel and worm gears, shafts, axes and spindles, Flexible Mechanical Elements, Belts, timing belts, chain and sprocket, flexible shafts, brakes, clutches, cams, four bar mechanism.

5. Design of Hydraulic System
Hydraulic circuit design, Actuator design, selection of pumps, selection of valves, design of control circuits

MTEE-052 POWER QUALITY

L T P
3 0 0

1. Power Quality Problems and Monitoring :

Introduction, surges, voltage sag and swell, over voltage, under voltage, outage voltage and phase angle imbalances, electrical noise, harmonic, frequency deviation monitoring.

2. Solution to power quality problems : Design, measures to minimize the frequency and duration of outages in distribution systems, voltages regulators, harmonic filters, power conditioners, uninterruptible power supplies, emergency and standby power systems, application of power conditioners.

3 Minimization of disturbances at Customer site : Power quality standards, standard test waveforms, power distribution system design, measure to minimize voltage disturbances.

References :

1. Roger C. Dugan, Mark F. Mcgranaghan, Surya Santoso, "Electrical Power System Quality", McGraw Hill
2. C. Sankaran, Power Quality CRC Press, USA
3. Wilson E. Kazibwe, "Electrical Power Quality Control Techniques", Van Nostrand Reinhold.
4. M. H. J. Bolen "Understanding Power Quality Problems", IEEE Press 2000.
5. J. Arrillaga, N.R. Watson, S. Chen "Powr System Quality Assessment", John Wiley, 2000.

MTEE-053 OPTIMIZATION TECHNIQUES

L T P
3 0 0

1.Linear programming –
formulation-Graphical and simplex methods-Big-M methodTwo phase method-Dual simplex method-Primal Dual problems.

2.Unconstrained one dimensional optimization techniques -
Necessary and sufficient conditions –Unrestricted search methods-Fibonacci and golden section methodQuadratic Interpolation methods, cubic interpolation and direct root methods.

3. **Unconstrained n dimensional optimization techniques –**
direct search methods – Random search –pattern search and Rosen brooch's hill claiming methodDescent methods-Steepest descent, conjugate gradient, quasi -Newton method.

4.Constrained optimization Techniques-
Necessary and sufficient conditions – Equality and inequality constraints-Kuhn-Tucker conditions-Gradient projection method-cutting plane method- penalty function method .

5.Dynamic programming-
principle of optimality- recursive equation approach-application to shortest route, cargo-loading, allocation and production schedule problems.

References :

1. Rao,S.S., Optimization :Theory and Application Wiley Eastern Press, 2nd edition 1984.
2. Taha,H.A., Operations Research –An Introduction,Prentice Hall of India,2003.
3. Fox, R.L., „Optimization methods for Engineering Design , Addition Welsey, 1971.