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

Syllabus

For

M. Tech

Electrical & Electronics Engineering

(Effective from Session: 2016-17)

EVALUATION SCHEME FOR M. TECH COURSES (ELECTRICAL & ELECTRONICS ENGINEEING)
TO BE EFFECTIVE FROM SESSION 2016-17
SEMESTER-I

S.No.	SUBJECT CODE	NAME OF THE SUBJECT	PERIODS			CREDIT	EVALUATION SCHEME					SUBJECT TOAL
			L	T	P		THEORY			PRACTICAL		
							CT	TA	ESE	TA	ESE	
1	MTEN-101	ADVANCED MICROPROCESSOR ITS APPLICATIONS	3	0	0	3	20	10	70	--	--	100
2	MTEN-102	POWER CONVERTERS	3	0	0	3	20	10	70	--	--	100
3	MTEN-011-013	DEPARTMENTAL ELECTIVE-I	3	0	0	3	20	10	70	--	--	100
4	MTEN-021-023	DEPARTMENTAL ELECTIVE –II	3	0	0	3	20	10	70	--	--	100
5		RESEARCH PROCESS & METHODOLOGY	3	0	0	3	20	10	70	--	--	100
6	MTEN-151	MICROPROCESSOR & MICROCOMTOLLER LAB	0	0	3	2	--	--	--	20	30	50
7	MTEN-152	POWER CONVERTER LAB	0	0	2	1	--	--	--	20	30	50
	TOTAL		**15**		**5**	**18**						**600**

DEPARTMENTAL ELECTIVE-I	MTEN-011	POWER SYSTEM OPERATION & CONTROL
	MTEN-012	ADVANCED INDUSTRIAL DRIVES & AUTOMATION
	MTEN-013	BIOMEDICAL INSTRUMENTATION

DEPARTMENTAL ELECTIVE-II	MTEN-021	OPTIMAL CONTROL
	MTEN-022	MODELING & DYNAMICS OF ELECTRICAL MACHINES
	MTEN-023	MECHATRONICS

SEMESTER-II

S.No.	SUBJECT CODE	NAME OF THE SUBJECT	PERIODS			CREDIT	EVALUATION SCHEME					SUBJECT TOAL
			L	T	P		THEORY			PRACTICAL		
							CT	TA	ESE	TA	ESE	
1	MTEN-201	ADVANCED DIGITAL SIGNAL PROCESSING	3	0	0	3	20	10	70	--	--	100
2	MTEN-202	POWER QUALITY & FACTS DEVICES	3	0	0	3	20	10	70	--	--	100
3	MTEN-031 - 033	DEPARTMENTAL ELECTIVE-III	3	0	0	3	20	10	70	--	--	100
4	MTEN-041 - 043	DEPARTMENTAL ELECTIVE –IV	3	0	0	3	20	10	70	--	--	100
5	MTEN-051 -053	DEPARTMENTAL ELECTIVE –V	3	0	0	3	20	10	70	--	--	100
6	MTEN-251	DIGITAL SIGNAL PROCESSING LAB	0	0	3	2	--	--	--	20	30	50
7	MTEN-252	SEMINAR-I	0	0	2	1	--	--	--	50	--	50
	TOTAL		**15**		**5**	**18**						**600**

DEPARTMENTAL ELECTIVE-III	MTEN-031	ADVANCED PROTECTING RELAYING
	MTEN-032	ENERGY SYSTEM MANAGEMENT
	MTEN-033	DIGITAL CONTROL SYSTEM

DEPARTMENTAL ELECTIVE-IV	MTEN-041	EHV AC & DC TRANSMISSION
	MTEN-042	SPECIAL ELECTRICAL MACHINES
	MTEN-043	SMART GRID

DEPARTMENTAL ELECTIVE-V	MTEN-051	SMART SEMSORS & INSTRUMENTATION
	MTEN-052	POWER SYSTEM PLANNING
	MTEN-053	NON CONVENTIONAL ENERGY SOURCES & ENERGY CONVERTERS

SEMESTER-III

S.No.	SUBJECT CODE	NAME OF THE SUBJECT	PERIODS			CREDIT	EVALUATION SCHEME					SUBJECT TOAL
			L	T	P		THEORY			PRACTICAL		
							CT	TA	ESE	TA	ESE	
1	MTEN-351	SEMINAR-II	0	0	6	3	--	--	--	100	--	100
2	MTEN-352	DISSERTATION	0	0	30	15	--	--	--	200	300	500
	TOTAL				**36**	**18**						**600**

SEMESTER-IV

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

I YEAR (I SEMESTER)

MTEN-101 : ADVANCED MICROPROCESSOR & ITS APPLICATIONS

L	T	P
3	0	0

Objective & Outcome of learning.

To make the students fully conversant with a 16 bit microprocessors and its peripherals and to expose them to advances in 32 and 64 bit microprocessors. It will also cover the 8 and 16 bit micro-controller which finds wide applications in Industry. After this course student may be able to design application software.

1 **Introduction :**
Review of basic microprocessors, architecture and instruction set of 8085 microprocessor.

2. **Evolution of advanced microprocessors:**
Introduction to 16, 32 and 64 bit microprocessors. Concepts of CISC, RISC, multi-processing, multi-user, multi-tasking, Virtual Memory, Segmentation, Cache Memory. Hyper Threading and Burst mode of operation. Parallel processors, dual and multi-core processors and supercomputers.

3. Architecture of 16 bit 8086 microprocessor and its working. Minimum and Maximum mode configuration. Memory organization. Its addressing mode, Instruction set and template. Interrupt structure. Assembly language programming and applications. Motorola 68000 processor & its architecture.

4. **MASM/TASM assembler:**
Statement syntax, common assembler directives, creating a source file, assembly and linking, loading and execution.

5. **Programmable Peripherals, their working and Interfacing:**
Parallel I/O (8255 PPI), Serial I/O (8251), RS-232C, and Modem, 8253/8254 Timer/counter, 8259 Interrupt controller and 8237 DMA, controller, 8287 Math Co-processor, AD and DA converters.

6. **Microcontrollers:**
Introduction to 8051 micro-controller family, pin description, its internal structure, Special Function registers, memory organization, addressing modes, and its syntax, Instruction set and its format. Working of its timer, interrupts and serial I/O Atmel microcontroller 89C51 and 89C 2051.

   Introduction to 8096/8097 family and essential difference with 8051.

7. **32 – bit microprocessor:**
Introduction to 80386 DX microprocessor, essential pin description, Internal registers, virtual memory, Segmentation and paging system. Internal and external cache memory and its organization.

References :

1. R.S. Gaonkar, “Microprocessor Architecture, programming and applications”, Wiley Eastern Limited.
2. Liu Gibson, “Micro-computer Systems the 8086/8088 family architecture”. Prentice Hall of India
3. D.V. Hall, “Microprocessors and Interfacing Programming” Revised 2nd Edition, Tata Macgraw Hill.
4. W.A. Triebel & Avatar Singh “The 8088 and 8086 Microprocessors” Fourth Edition, 2003 Prentice Hall India.
5. A.V. Desh Mukh “Microcontrollers- Theory and Applications” Tata Mc Graw Hill.
6. Mohammed Rafiquzzaman “Microprocessor and Micro-controller Based System Design” Universal Books Stall, New Delhi.
7. Muhammad Mazidi and Janice Mazidi” The 8051 microcontroller & Embedded Systems” Prentice Hall 2000.
8. B.P. Singh and Renu Singh “Advanced Microprocessors and Microcontrollers” New Age 2002.

Related Journals & Books for applications & advanced works.

(i) IEEE Transactions on Embedded Systems.
(ii) NPTEL Courses on Electrical Engg.

MTEN-151: MICROPROCESSOR & MICROCONTROLLER LAB

L T P
0 0 3

LIST OF EXPERIMENTS

1. To study 8085 microprocessor kit and all IC chips.
2. To study 8086 based microprocessor kit and all IC chips.
3. To develop and run a program for arranging in ascending/descending order of a set of number.
4. (a) To perform conversion of temperature ^{o}F to ^{o}C and vice-versa,
   (b) To perform computation of square root of given number.
5. To write a program for generating square wave with 8253/8254. The periodic time of the wave is 2 msec & 10msec.
6. To write a program for generating square wave with 8255, the periodic time of the wave is 2 msec & 10 msec.
7. To write a program to convert analog input to 0809 ADC to the digital output.
8. Study of Intel 8051 microcontroller kit and its commands.
9. Generation of triangular wave using 8051 kit.
10. Generation of square wave form using 8051 kit.
11. Rotating of stipple motor using 8051 kit.
12. Reading input through DIP switches and their display using LED / 7-segment display.

MTEN-102: POWER CONVERTERS

L T P
3 0 2

1. Power Semiconductor Devices :
Review of power semiconductor devices, i.e. SCR, Triac, GTO Thyristor, Power Transistor, Power MOSFET, Insulated Gate Bipolar Transistor (IGBT), MOS Controlled Thyristor (MCT); trigger techniques, protection.

2. Line Commutated Converters:
Full and half controlled converters, effect of load and source inductances; performance parameters, dual converters, power factor improving techniques.

3. AC Voltage Controllers:
Operation and performance of single phase and three phase ac voltage controllers, solid state ac and dc transfer switches.

4. DC-DC Converters :
Commutation techniques of SCR, chopper control techniques, step down chopper with RL& RLE load, step-up chopper, multi-phase configuration. Impulse commutated and resonant pulse choppers, introduction to speed control of dc motors.

5. Inverters:
Single phase series resonant inverter, single phase and three phase bridge inverters, voltage control and harmonics reduction techniques, current source inverter, Introduction to speed control of induction motors.

References :

1. M.H. Rashid, “Power Electronics: Circuits, devices and Applications”’ Prentice Hall of India, 1996
2. N. Mohan, T.M.Undeland and W.P. Robbins, “Power Electronics; Converters, Applications and design”’ John Wiley and Sons, 1995
3. M.D. Singh and K.B. Khanchandani, “Power Electronics”,Tata McGraw Hill, 2001
4. S.N. Singh, “ A Text Book of Power Electronics”’ Dhanpat Rai & Co, 2000
5. A.K. Gupta, L.P. Singh, “Power Electronics: An Introduction to Drives”, Dhanpat Rai Publishing Co.,2001

6 V. Subrahmanyam, ‘Power Electronics”’ New Age International Publishers, 1997.

MTEN-152:POWER CONVERTER LAB

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-I

MTEN-011:POWER SYSTEM OPERATION AND CONTROL

L T P
3 0 0

Objective & Outcome of learning.

To impart knowledge about the structure and control aspect of the power system operation. This includes SCADA, optimal economic operations, AGC control, excitation and reactive power control, system security and the elements of FACTS control. At the end of the course a student will be able to do operations at a Load dispatch centre or planning such operations.

1. Introduction:

Large scale power systems-their interconnections and operation; load dispatch centre and control centre, introduction to centralized and decentralized controls; various operational stages of power system; power system security.

2. Economic Operation:

Problem of unit commitment, system constraints, incremental fuel cost, economic load scheduling with and without transmission losses, penalty factor, loss coefficient, incremental transmission loss ; optimal power flow problem ; optimal operation of hydro-thermal system.

3. Load Frequency Control:

Concept of load frequency control, speed governing systems and its representation, automatic control, modeling of single area and multiarea systems, tie line control, supervisory control ; automatic generation control including excitation system; optimum load frequency controller, PID controller.

4. Voltage Reactive Power Control:

Concept of voltage control, methods of voltage control, reactive power injection, control by tap changing transformer, series compensation, static VAR compensation, Excitation system & stabilizer, rate feedback controller, PIDcontroller.

5. State Estimation:

State estimation, linear and nonlinear models, detection and identification of measurement errors.

6. Flexible AC Transmission System :

Concept and objectives, basic FACTS controllers: TCR,FC-TCR, TSC, SVC, STATCOM, TCSC, SSSC, PAR and UP FC

References:

1. O.I. Elgerd, “Electric Energy System Theory”, Mc Graw Hill, 1971
2. Leon K. Kirchmayer, “Economic operation of Power Systems” Wiley Eastern Ltd.,
3. A. Chakrabarti, D.P. Kothari and A.K. Mukhopadhyay, “Performance Operation and Control of EHV Power Transmission Systems”, Wheeler Publishing Co.
4. A. J. Wood & B.F. Wolfenberg “Power Generation Operation and control” Second Edition John Wiley & Sons.
5. D.P. Kothari & J.S. Dhillon “Power System Optimization” Prentice Hall, 2004.
6. HG Hingorani and L Gyugyi “Understanding FACTS”, New York, IEEE Press 2000.
7. K.R. Padiyar “FACTS Controllers in Power Transmission and distribution” New Age Delhi, 2007.

Related e-Journals and books for advanced work.

(i) IEEE Transactions on Power System
(ii) IEEE Transactions on Power Delivery
(iii) IET Research Journal on Generation, Transmission and Distribution
(iv) NPTEL Courses on Electrical Engg.

MTEN-012 : ADVANCED INDUSTRIAL DRIVES & AUTOMATION

L T P
3 2 0

1. **Introduction:**
   Definition, Types of loads, steady state & transient stability of drives, state of art of power electronics and drives, selection of motor rating, open-loop control and closed-loop control, transfer function and state space modeling, PSIM/ MATLAB.

2. **D.C. Drives:**
   Review of braking and speed control of D.C. motors, multi-quadrant operation, loss minimization in adjustable speed drives. Mathematical modeling of dc drives, stability analysis, modern control techniques: variable structure, adaptive control, Simulation of open loop and closed loop control of DC motor.

3. **Induction motor drives:**
   Review of braking and speed control of induction motors. Constant V/F, constant air gap flux, controlled voltage, controlled current and controlled slip operation. Mathematical modeling of induction motor drives, transient response and stability analysis Introduction to cyclo-converter fed induction motor drive, Simulation of open loop and closed loop control of induction motor.

4. **Synchronous motor drives:** Adjustable frequency operation, voltage fed drive, current fed self-controlled drive, Simulation of open loop and closed loop control of synchronous motor.

5. **Automation using drives:** Introduction, various components of automation, different sensors used in automation, PLC introduction and ladder programming, industrial application of automation, sensor less vector control and DTC drive, recent trends in automation and case studies.

Reference Books:

1. Dubey G.K., Power Semiconductor Controlled Drive, Prentice Hall, New Jersey
2. Sen P.C., Thyristor Controlled DC Drives, Wiley, New York.
3. Murphy J.M.D. and Turnbull F.G., Power Electronics Control of AC Motors, Franklin Book Co.
4. Bose B.K., Power Electronics and AC Drives, Prentice Hall, New Jersey.
5. Bose B. K., Power Electronics and Variable Frequency Drives-technology and applications, IEEE Press.

MTEN-013: BIO-MEDICAL INSTRUMENTATION

L T P
3 1 0

1. **Characteristics of Transducers and Electrodes for Biological Measurement:**
   Introduction to human body; block diagram, classification, characteristics, Various physiological events and suitable transducer for their recording, Bioelectric potentials.

2. **Cardiac System:**
   Cardiac musculature, Electro cardiography, ECG recording, Phonocardiography, holter recoding ECG lead system, Heart rate meter, vector cardiography, Pacemakers, Defibrillators.

3. **Blood Pressure and Blood Flow Measurement:**
   Invasive and non-invasive methods of Blood ressure, Characteristics of blood flow and heart sound, Cardiac output measurement, Plethysmography.

4. **Respiratatory System:**
   Mechanics of breathing, Parameters of respiration, Respiratory system measurements, Respiratory therapy instruments.

5. **Muscoskeletal systems:**
   EMG, Clinical applications, Muscles stimulator.

6. **Instrumentation for Measuring Nervous Function:**
   EEG signal, frequency band classification, Lead systems, EEG recording, Clinical applications of EEG signal, X-ray CT scan, MRI, PET.

7. **Clinical Laboratory Instrumentation:**
   Test on blood cell, Blood cell counter, Blood glucose monitors, auto analyzer, Pulse-oximeter.

8. Recent Trends in Biomedical Engineering:
Patient care and monitoring, Non-invasive diagnostic instrumentation, Biotelemetry, Telemedicine, Prosthetic devices, Lie detector test, Application of lasers and ultrasonic in biomedical field.

9. Troubleshooting & Electrical Safety of Biomedical Instruments:
Physiological effect of current and safety measurement, Design of biomedical instruments, Simulations on various biomedical applications.

Reference Books:

1. Biomedical Engineering Fundamentals by Bronzino, CRC Press
2. A Textbook on Biomedical Engineering by R M Kenedi, Balckie
3. Introduction to Biomedical Engineering by Enderle & Bronzino, Academic Press

ELECTIVE-II

MTEN-021: OPTIMAL CONTROL

L T P
3 0 0

UNIT-I:
Optimal control law, the principal of optimality, application of their optimality principle to decision making, an optimal control system. Recurrence relation of dynamic programming, computational procedure for solving control problem, characteristics of dynamic programming solution.

UNIT-II:
Discrete linear regulator problem. Hamilton –jocobi-bellman equation. Continuous linear regulator problems, necessary and sufficient conditions examples.The calculus of variations & Pontrygin's minimum principle: Fundamental concepts, functional of a single function, functional involving several independent functions, necessary conditions for optimal control, linear regulator problem.

UNIT-III:
Pontrygin's minimum principle and state inequality constrains, minimum time problems, minimum control effort problems. Iterative numerical techniques for finding optimal controls and trajectories: Two point boundary value problems, method of steepest descent algorithm, variation of extremalas, variation of extremal algorithm, gradient projection algorithm

UNT-IV:
The nature of the state estimation problem, non-statistical estimation design with full estimator dimension, non-statistical estimation with reduced estimator design.

UNIT-V:
Description of plants noise statistics, statement of optimal estimation problem, information of the optimal estimation problem as an optimal regulator problem, solution to the regulator problem in feedback form, explicit solution of the optimal estimation problem.

TEXT BOOKS:

1. Jasbir S. Arora, Introduction to optimum design, Elesevier, 2005.
2. A Ravindran, K.M. Ragsdell, and G.V. Reklaitis, Engineering optimization : Methods and applications, Wiley India Edition.
3. Donald E.Kirk, Optimal Control Theory an Introduction, Prentice - Hall Network series - First edition, 1970.

REFERENCE BOOKS:

1. D.S. Naidu, Optimal control systems, CRC Press, First edition, 2002.
2. Arturo Locatelli, Optimal control: An Introduction, Birkhauser Verlag, 2001.
3. S.H.Zak, Systems and Controll, Indian Edition , Oxford University, 2003.
4. Niclas Anreasson, Anton Evgrafov and Michael Patriksson, An introduction to continuous optimization, Overseas Press (India) Pvt. Ltd.
5. Optimal control systems-A.P. Sage
6. Optimal Theory and application –Dr.S.S.Rao-eastern Willy- First edition

MTEN-022 : MODELING & DYNAMICS OF ELECTRICAL MACHINES

L T P
3 2 0

1. Introduction:
Challenges in computer simulations, Mechanics of simulation, solution techniques for time domain analysis, introduction of widely used circuit- oriented simulators like Pspice, MATLAB, PSIM, equation solvers, simulation of power electronics circuits and converters.

2. Dynamic Conditions:
Concept, constraints and considerations; modeling and performance simulation methods, concept of reference frame, generalized transformation, formulation of dynamic equations of a generalized machine in arbitrary reference frame.

3. D.C. Machine Dynamics:
Ideal machine; dynamic equation; transfer function and block diagram; linear analysis of D.C. generators; effects of saturation; analysis and performance under disturbances. Switching and surge voltage transients in transformers.

4. Induction Machines:
Transients and dynamics; basic electro mechanical equations; linearized and non-linearized analysis; operation on harmonic supplies; unbalanced operation.

5. Synchronous Machine Transients:
Coupled circuit viewpoint; approximate physical picture, equivalent circuit under transient conditions and its applications; synchronous motor operation with variable/fixed load torque and excitation; equal-area criterion for the study of transient stability.

Reference Books:

1. Krause P.C., Electric Machinery, McGraw Hill
2. Kimbark E.W., Power System Stability Vol 3 Synchronous Machine, John Wiley & Sons
3. Concordia C., Synchronous machines, Theory and Performance, John Wiley & Sons.
4. Adkins B. and Harley R. G., The General theory of Alternating Current Machines, Chapman & Hall

NEN-023 : MECHATRONICS

L T P
3 2 0

1. Objective & Learning Outcome
With an overview of mechanical, electrical, optical and control technologies, it strives to optimally integrate different technologies with computer systems in order to create high quality products and processes.

This should enable students to develop knowledge and skills to adopt interdisciplinary and integrated approach to engineering design while being able to design, construct and evaluate simple automated system requiring electronic, pneumatic and optical circuit integration.

2. **Syllabus**
Its elements – such as mechanics, electronics, microelectronics, power electronics and information technologies.

Mechanical elements with integrated electronics, suspension systems, vibration dampers, clutches, bearings – mechanical / magnetic, gears etc. Micro-motors dc-micro motors, PCB motors, disc motors, reluctance motors, PM motors(Materials, design & contruction), Brushless motors, stepper motors, universal motors, aerial field motors, Induction motors and synchronous motors.

Applications to Tele-communication technology equipment, computer printers actuators consumer products such as cameras, camcorder, timers, clock, VCR, wipers, fax machines, recorders.

Text Books / References:

1. Bolten, “Mechatronics”
2. V. Athani, “Stepper Motors Fundamentals, Applications and Design” New Edge Intl.
3. T.J.E. Miller, “Switched Reluctance Motors and their control” Oxford 1993
4. J.F. Gieras and M. Wing, “Permanent Magnet Motor Technology” (M.Dieker)1997 Y. Dote & S Kinoshika, “Brushless Servo motor fundamentals and applications” Calrendon Press Oxford

I YEAR (II SEMESTER)

MTEN-201: ADVANCED DIGITAL SIGNAL PROCESSING

L T P
3 2 0

1. Discrete-Time Signals and Systems:
Discrete-Time Signals, Discrete-Time Systems, Analysis of Discrete-Time Linear Time-Invariant Systems, Discrete Time systems described by Difference Equation, Implementation of Discrete-Time Systems, Signal flow Graph representation of digital network, matrix representation.

2. The z-Transform:
The Direct z-transform, Properties of the z-transform, Rational z-transforms, Inversion of the z transform, analysis of Linear Time-Invariant systems in the z- domain.

3. Discrete Fourier Transform:
Frequency Domain Sampling: The Discrete Fourier Transform Frequency- Domain Sampling and Reconstruction of Discrete-Time Signals. The Discrete Fourier Transform (DFT). The DFT as a linear Transformation. Relationship of the DFT to Other Transforms. Properties of the DFT. Periodicity, Linearity, and Symmetry Properties. Multiplication of two DFTs and Circular Convolution. Additional DFT Properties. Frequency analysis of signals using the DFT.

4. **Basic IIR Filter Structures**:
Direct forms (I & II), cascade and parallel realizations. Signal flow graph,
Transposed structure, Basic FIR filter structures-. Direct form structure, frequency sampling structure, Lattice structure, Linear phase FIR structure.
Symmetric and Anti-symmetric FIR Filters, Design of Linear-Phase FIR Filters Using Windows, Design of Linear-Phase FIR Filters by the Frequency Sampling Method, Design of FIR, Equiripple filter design Differentiators. Design of Hilbert Transformers.

5. Design of IIR Filters From Analog Filters:
IIR Filter Design by Approximation of Derivatives, IIR Filter Design by Impulse Invariance. IIR Filter Design by the Bilinear Transformation. The Matched-z Transformation, Characteristics of Commonly Used Analog Filters, Application of above technique to the design of Butterworth & Chebyshev.

MTEN-251: DIGITAL SIGNAL PROCESSING LAB

L T P
0 0 3

1. Study of Code Composer Studio of TMS320C6713 DSP Starter Kit (DSK).
2. Study of TMS320C6713 DSP Starter Kit (DSK) and its chip set.
3. Generation of Sinusoidal waveform / signal based on recursive difference equations.
4. To find DFT / IDFT of given DT signal.
5. Implementation FFT of given sequence.
6. Implementation of LP FIR filter for a given sequence.
7. Implementation of LP IIR filter for a given sequence.
8. Generation of sinusoidal signal through filtering.
9. Implementation of Interpolation Process.
10. Impulse response of first order and second order systems.

NEN-203 : POWER QUALITY AND FACTS DEVICES

L T P
3 2 0

1. Overview:
Sources of pollution and regulations, various power quality problems, transmission problems and needs, the emergence of FACTS, FACTS controller & consideration.

2. Harmonics:
Effects-within the power system, Interference with communication Harmonic measurements, Harmonic elimination, Harmonic distortion due to various sources, Effects of harmonic distortion, THD calculation, Harmonic filter design, Active and Passive Filters.

3. Monitoring power quality:
Monitoring essentials, reliability indices, Power quality measuring equipment, Current industry trends, Fourier series, Fourier transform and wavelet transform.

4. Series and shunt compensation:
Fundamental of series compensation, principle of operation, TCSC operation in power system, SSSC :principle of operation, Shunt SVC principles, configuration & control, STATCOM, Modeling and applications of series and shunt compensating devices.

5. Phase shifter:
Principle of operation, steady state model of static phase shifter, operating characteristics of SPS, power current configuration of SPS applications.

6. Unified power flow controllers:
Basic operating principles & characteristics, control UPFC installation applications, UPFC model for power flow studies.

Reference Books:

1. Song Y.H. and Johns A.T., "Flexible AC Transmission Systems", IEEE Press.
2. Hingorani N.G. and Gyragyi L., "Understanding FACTS (Concepts and Technology of Flexible AC Transmission System)", Standard Publishers & Distributors, Delhi.
3. Ghosh A. and Ledwich G., "Power Quality Enhancement using Custom Power Devices", Kluwer Academic Publishers.
4. Mathur R.M. and Verma R.K., "Thyristor based FACTS controllers for Electrical Transmission Systems", IEEE Press.
5. M.H.J. Bollen, Understanding Power Quality and Voltage Sag, IEEE Press.

ELECTIVE-III

MTEN-031: ADVANCED PROTECTIVE RELAYING

L T P
3 0 2

Objective & Outcome of learning.
To impart advanced knowledge in static & microprocessor based protective relaying which have replaced / replacing the old electromagnetic relays and to a certain extent even the static relays. This also includes the protection schemes of long transmission lines. At the end of the course student will be confident to handle modern Power System relaying systems.

1. **Introduction**
Essential qualities of protection, zones of protection, classification of relays, basic protective schemes.

2. **Comparators**
Transfer impedance, mixing circuits, amplitude and phase comparators and their duality, static realization of amplitude and phase comparators, multi-input comparators.

3. **Static Relays :**
Basic construction, input-output devices, merits and demerits of static relays, application of solid state devices.

4. **Static Protection :**
Over current relaying schemes, differential relaying schemes, distance relaying schemes, power swing, carrier protection of long lines, protection of multiterminal lines, new type of relaying criteria, quadrilateral relay, elliptical relay, restricted distance relays.

5. **Digital Protection :**
Concept of digital protection, microprocessor based over current and distance relay schemes, generalized interface for distance relays.

References :

1 A.R. Van C. Warrington, “Protective Relays- Their theory and practice Vol.I II”, John Wiley Sons, 1977

2 B.D. Russel and M.E. Council, “Power System Control and Protection” Academic Press, 1982,

3. T.S.M. Rao, “Power System Protection with Microprocessor Applications” Tata Mc. Graw Hill, 1989
4. B.Ravindranath and M.Chander, “Power System Protection and Switchgear” Wiley Eastern, 1977
5. S.S. Rao, “Switchgear and Protection” Khanna Publishers, 1986
6. B.Ram and D.N. Vishwakarma, “Power system Protection and Switchgear” Tata McGraw Hill, 1995
7. W.A. Elmore (Editor) “Protective Relaying – Theory and applications”, Coral Spring Florida. (ABB Power and T&D Co.)
8. A.G. Phadke and J.S. Thorp “Computer based relaying” Research Studies Press John Wiley 1988.
9. A.T. John and S.K. Salman “Digital Protection of Power System” Peter Paregrinus, IEE Pub 1995.
10. S.H. Horwitz and Arun G. Phadke “power System Relying” John Wiley & Sons (Research Study Press) 1992.
11. IEEE Tutorial Course “Advancement in microprocessor Based Protection & Communication” course coordinator M.S. Sachdev 97TP 12-70, 1997.
12. J.S. Lewis Blackburn (Editor) “Protective Relaying Principles & Applications” Third Edition, CRC Press 2007.

Related e-Journals and books for advanced work.

(i) IEEE Transactions on Power System
(ii) IEEE Transactions on Power Delivery
(iii) IET Research Journal on Generation, Trans and Distribution
(iv) NPTEL Course on Electrical Engg.

MTEN-032: ENERGY SYSTEM MANAGEMENT

L T P
3 0 0

Objective & Outcome of learning

To emphasize the important problem of integrated energy management. This involves the improving efficiencies & economics of equipment used including retrofitting. It includes the life cycle savings & payback period & return of investments. Energy audit is another important area which may be handled here. At the end of the course a student will be better equipped to think in terms of overall system efficiencies & economics.

I. Energy Resources:

Perspective on energy resources, Utilization and demand projections, Energy resource definition & classification, Causes of Energy scarcity and social disparity, Energy as a parameter of Techno-Socio-Economic development, Factors solving the energy crunch, Energy system model – Description & qualitative analysis, Acceptability Index and its significance.

II. Concept Of Energy Management Definition and Significance, Benefits, Classifications, Key Issues - Techno economic Issues, Programmatic and Institutional Issues, Energy management implementation criteria, Approaches of Energy management: Procedural Energy Management Opportunities (PEMOS), Equipment Modifications, Additions or Replacement EMOS (Retrofit EMOS), Research and Development and New Installation (R&DEMOS), Resource or Fuel Substitution (Substitution EMOS), Examples for each. Comparative features.

III. General Principles Of Energy Management Proper/Optimal Control, Optimize Capacity, Reduce Loads, More Efficient Equipment and Appliances, More Efficient Processes, Employ Special Techniques to Reduce Losses, Energy Containment, Cascade Energy Use, Energy Conversion & storage Principle. (Introduction with examples & comparative features).

IV. Energy Efficiency Analysis Different types of losses involved in Process and industry. First Law of Efficiency, simple examples & calculations, Limitation, Efficiency and its significance Second law of Efficiency – Quality of Energy form, Available work, Coefficient of Performance (COP), Effectiveness, Simple calculations.

V. Energy Economics Comparison of alternatives options; Simple economic calculations, Life cycle casting, Life cycle savings, payback period and return of investments. Break Even Analysis & its limitations, Benefit / Cost analysis, Time value of money , Calculation of present worth & present worth factor, Simple calculation of Payback period, solar energy economics.

(I) Case study:-Electric loads- Lighting, Motor and Power; Fluid Flow Control- pump, fan, blower, and compressor; Residential colony.

(II) Planning For Energy Management- Planning phases; Initial phase decision to Undertake Program, Commitment by Management, Statement of Objectives.

Analysis and simulation phase- Database and information collection, Energy Audit, Computer Analysis and Simulation. Implementation phase- implementation, Monitoring of program, periodic review, Modification, and optimization. Modeling and parameter for planning.

References :

1. C.B. Smith ,'Energy Management Principles' Pergammon Press, 1981
2. Y. Y. Haimes (ed), 'Energy Auditing and Conservation'. Hemisphere Publishing Corporation, New York, 1980.
3. J. S. Hsieh, 'Solar Energy Engineering'. Prentice Hall Inc, New Jersey, 1981.
4. D. Millington.'System Analysis and Design for Computer Applications'. Affiliated East West Press Pvt Ltd, New Delhi, 1981.

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

MTEN- 033 : DIGITAL CONTROL SYSTEM

L T P
3 0 0

1. Digital Control Systems:
Introduction to digital control, z-transform and inverse z-transform, z-transform model of the physical systems, Zero-order, First-order and fractional-order hold circuits, Pulse transfer function and its determination, Realization of digital controller and digital filters.

2. Digital Control Analysis:
Analysis of Discrete time Control System, Mapping of s-plane & z-plane, Stability analysis of discrete time system using Jury's stability criterion, Transient and Steady State Responses of discrete time system. Root locus analysis of discrete time system.

3. Frequency Response Analysis:
Frequency response analysis of discrete time system Bilinear Transformation mapping of z-plane to w-plane, Bode plot analysis of Discrete Time System, Lag, Lead & Lag Lead compensator design using Bode plot analysis.

4. Discrete Controllers:
Modeling and implementation of discrete PID controller, Tuning of Discrete PID Controller Study of discrete position and temperature control systems.

5. State-Space Analysis of Discrete Time System:
State-space representation of discrete time system, Solution of discrete-time state equation, Discretization of continuous-time state equation, Discrete-time state-space model to transfer function model and vis-a-versa. Concept of observability & controllability and their testing in discrete time system.

Text Books:

1. B.C.Kuo, "Digital Control System",Saunders College Publishing.
2. M.Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill.
3. K. Ogata, "Discrete Time Control System" Prentice Hall.

Reference Books:

3. R.Leigh, "Applied Digital Control", Prentice Hall, International
4. C.H. Houpis and G.B.Lamont, "Digital Control Systems:Theory, hardware, Software", Mc Graw

ELECTIVE-IV

MTEN- 041 : EHVAC AND HVDC TRANSMISSION

L T P
3 0 0

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

1. **Introduction :**
   Need of EHV transmission, comparison of EHV AC & HVDC transmission, mechanical considerations of transmission line.

2. **EHV AC Transmission:**
   Parameters of EHV lines, Voltage gradient in bundle conductors lines, conductor sizing, over-voltages due to switching, ferro resonance. Insulation coordination line insulators and clearances, Corona & its effects, power loss, audible noise and radio-interference, long distance transmission with series and shunt compensations, principle of half wave transmission, flexible ac transmission

3. **HVDC Transmission :**
   Types of dc links, terminal equipments & their operations, HVDC control system, reactive power control, harmonics and filters, multiterminal dc (MTDC) system, ac/dc system analysis, protection of terminal equipments. HVDC transmission based on voltage source-converters.

References :

1. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering" Revised Second Edition, John Wiley.
2. K.R. Padiyar, "HVDC Power Transmission System", Second revised Edition, New Age Int. 2012
3. S. Rao, "EHV-AC and HV DC Transmission Engineering Practice", Khanna Publishers.
4. Arrillaga J "High Voltage Direct current Transmission" 2nd Edition (London) Peter Peregrinus, IEE, 1998.
5. Hingorani HG and Gyugyi L "Understanding FACTS-concepts and Technology of Flexible AC Transmissions Systems" New York, IEEE Press,2000.
6. Padiyar K R "FACTS controllers in Power Transmission and distribution" New Delhi, New Age Int. publishers 2007.

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 Engg.

MTEN-042 : SPECIAL ELECTRIC MACHINES

L T P
3 0 0

1. **Special AC Machines:**
   Constructional aspects, design and analysis of reluctance, shaded pole, hysteresis, printed circuit, claw motors, Servomotors and A.C. tacho-generators.

2. **Devices:**
   Introduction of permanent magnet materials, angled field and axial field devices, cross-field machines, special forms of rotating amplifiers, electromagnetic clutches, coupling and brakes, eddy current devices.

3. **Linear Machines:** Linear devices and actuators Linear electric machines: Classification, application, constructional aspects, design and method of analysis of various types, Goodness factor.

4. **Linear Electric Motors:** Transverse-edge, entry-end, exit end, short primary, short secondary effects in linear electric motors, Force, energy and power LEMs for low speed medium speed and high speed applications. Electromagnetic levitation and guidance schemes-attraction, repulsion.

5. **Advanced Motors and Drive Systems** Principle, construction, operation and drive application of Square wave Permanent Magnet (PM) brushless motor drives, sine wave PM brushless motor drives, PM and synchronous reluctance based motors, switched reluctance motors, Energy efficient motors.

Reference Books:

1. B.K. Bose, Power Electronics and variable frequency drives, Prentice Hall, New Jersey.
2. T.J.E. Miller, Brushless permanent magnet and reluctance motor drives, Oxford University Press, UK.
3. S.A. Nasar, Linear induction motor, John Wiley, New York.
4. J. C. Andreas, Energy Efficient Motors, Marcel Dekker.
5. J.M.P. Murphy, Power Electronics control of AC Drives, Pergamon Press.

MTEN-043 : SMART GRID

L T P
3 0 0

Unit I
Introduction to Smart Grid:
Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid. CDM opportunities in Smart Grid.

Unit II Smart
Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

Unit III
Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

Unit IV Microgrids and Distributed Energy Resources: Concept of microgrid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.

Unit V
Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley
4. Jean Claude Sabonnadière, Nouredine Hadjsaïd, “Smart Grids”, Wiley Blackwell 19
5. Peter S. Fox Penner, “Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities”, Island Press; 1 edition 8 Jun 2010
6. S. Chowdhury, S. P. Chowdhury, P. Crossley, “Microgrids and Active Distribution Networks.” Institution of Engineering and Technology, 30 Jun 2009
7. Stuart Borlase, “Smart Grids (Power Engineering)”, CRC Press

Reference Books:

1. Andres Carvallo, John Cooper, “The Advanced Smart Grid: Edge Power Driving Sustainability: 1”, Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson “Control and Automation of Electric Power Distribution Systems (Power Engineering)”, CRC Press
3. Mladen Kezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert “Substation Automation (Power Electronics and Power Systems)”, Springer
4. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, “Electrical Power System Quality”, 2nd Edition, McGraw Hill Publication.

MTEN-051: SMART SENSORS & INSTRUMENTATIONS

L T P
3 2 0

1. Transducers:
Analog and digital transducers, including semi-conductor and optical. Application to measurement of temperature, pressure, flow, displacement and other non-electrical quantities.

2. Intelligent Sensors:
Integrated, smart and intelligent sensors, General Structure of smart sensors & its components, Characteristic of smart sensors: Self calibration, Self testing & self communicating, Applications of smart sensors.

Introduction to data acquisition system, A/D and D/A converters, sample and hold circuit, MUX and DEMUX, Signal transmission; Introduction to AM, FM, FSK, PSK and PCM, modulation and demodulation. Frequency and time division multiplexing Telemetry, GBIP,IEEE, profibus, device-net, Control Ner, MODBUS

3. Virtual Instrumentation:
Introduction, Graphical System Design Model, Design Flow with GSD, Virtual Instrumentation, Virtual Instrument and Traditional Instrument, Hardware and software in Virtual Instrumentation, Virtual Instrumentation for Test, Control and Design, Virtual Instrumentation in the Engineering Process, Virtual Instruments beyond personal Computer, Graphical System design using LabVIEW, Graphical Programming and Textual Programming, modular Programming, Data Structure , Cluster.

Text Books / References:

1. Barney “Intelligent Instrumentation” (PHI)
2. Jovita Jerome “Virtual Instrumentation” (PHI)
3. Helfrick & Cooper “Modern Electronic Instrumentation and Control” (PHI)
4. Border & Mayewize “Telemetry System”
5. Schewher “Data Communication” (Mc-GrawHill)
6. Patranabis “Telemetry Principles (TMS).

MTEN-052: POWER SYSTEM PLANNING

L T P
3 0 0

Objectives of planning –
Long and short term planning. Load forecasting – characteristics of loads – methodology of forecasting – energy forecasting – peak demand forecasting – total forecasting – annual and monthly peak demand forecasting.

Load forecasting Objectives of forecasting –
Load growth patterns and their importance in planning - Load forecasting Based on discounted multiple regression technique-Weather sensitive load forecasting-Determination of annual forecasting-Use of AI in load forecasting.

Expansion planning
Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

Distribution system planning overview
Introduction, sub transmission lines and distribution substations-Design primary and secondary systems-distribution system protection and coordination of protective devices.

Reference:

1. R.L. Sullivan, “Power System Planning”, Tata McGraw Hill Publishing Company Ltd, 2012.
2. X. Wang & J.R. McDonald, “Modern Power System Planning”, McGraw Hill Book Company,1994.
3. T. Gonen, “Electrical Power Distribution Engineering”, McGraw Hill Book Company, 1986.

MTEN – 053: NON-CONVENTIONAL ENERGY RESOURCES AND ENERGY CONVERTERS

L T P
3 2 0

1. Objective & Outcome 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.

2. **Introduction :**

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

3. **Solar Energy :**

Solar photovoltaics: 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.
Solar thermal**:** Thermal characteristics of solar radiation, solar collectors:-materials, types, focussing. 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. Applications, recent developments.

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.