Annexure

SARDAR VALLABHBHAI NATIONAL INSTITUTE OF TECHNOLOGY, SURAT

DEPARTMENT OF ELECTRICAL ENGINEERING

M. Tech. Programme
In
Power Electronics and Electrical Drives
Course Structure and Scheme of Evaluation (Semester-wise)

SEMESTER – I

Sr. No.	Course Code	Course	L	T	P	Credits	Examination Scheme				
			Hrs	Hrs	Hrs		Theory Marks	Tutorial Marks	Termwork Marks	Practical Marks	Total Marks
1	EL601	Power Electronics – I	3	1	2	05	100	25	20	30	175
2	EL603	Modeling of Electrical Machines and DC Drives	3	1	2	05	100	25	20	30	175
3	EL605	Digital Signal Processing	3	0	2	04	100	-	20	30	150
4	EL607	Fundamentals of System Theory	3	0	0	03	100	-	-	-	100
5	ELXXX	Elective I	2	0	2	03	100	-	20	30	150
		TOTAL	**14**	**2**	**8**	**20**	**500**	**50**	**80**	**120**	**750**
		TOTAL	**24**			**20**					

Elective I

(From amongst the electives one subject will be offered to each group of candidates)

EL609	Instrumentation for Drives
EL611	Embedded Systems
EL613	Power Quality Issues & Management
EL615	Neural Network & Fuzzy Logic
EL617	Microcontroller Based System Design

SEMESTER – II

Sr. No.	Course Code	Course	L	T	P	Credits	Examination Scheme				
			Hrs	Hrs	Hrs		Theory Marks	Tutorial Marks	Termwork Marks	Practical Marks	Total Marks
1	EL602	Power Electronics – II	3	1	2	05	100	25	20	30	175
2	EL604	AC Drives	3	1	2	05	100	25	20	30	175
3	EL606	Introduction to 32-bit Digital Signal Controllers	3	0	2	04	100	-	20	30	150
4	EL608	Applications of Power Electronics to Power Systems	3	0	0	03	100	-	-	-	100
5	ELXXX	Elective II	2	0	2	03	100	-	20	30	150
		TOTAL	**14**	**2**	**8**	**20**	**500**	**50**	**80**	**120**	**750**
		TOTAL	**24**			**20**					

Elective II

(From amongst the electives one subject will be offered to each group of candidates)

EL610	Special Machines
EL612	PLC & DCS
EL614	HVDC
EL616	Wind and Solar Energy Power Conversion
EL618	Modern Control Systems

SEMESTER – III

Sr. No.	Course Code	Course	L	T	P	Credits	Examination Scheme				
			Hrs	Hrs	Hrs		Theory Marks	Tutorial Marks	Termwork Marks	Practical Marks	Total Marks
1	EL701	Seminar	0	0	4	02	-	-	20	30	50
2	EL703	Dissertation Preliminary	0	0	16	08	-	-	100	150	250
		TOTAL	**0**	**0**	**20**	**10**	**-**	**-**	**120**	**180**	**300**
		TOTAL	**20**								

SEMESTER – IV

Sr. No.	Course Code	Course	L	T	P	Credits	Examination Scheme				
			Hrs	Hrs	Hrs		Theory Marks	Tutorial Marks	Termwork Marks	Practical Marks	Total Marks
1	EL702	Dissertation	0	0	24	12	-	-	160	240	400
		TOTAL	**0**	**0**	**24**	**12**	**-**	**-**	**160**	**240**	**400**
		TOTAL	**24**								

Total : 62 credits

M. Tech. (Electrical), Semester – I	L	T	P	C
EL601: POWER ELECTRONICS – I	**3**	**1**	**2**	**5**

- **REVIEW OF POWER SEMICONDUCTOR DEVICES** **(10 Hours)**

  Review of Power semiconductor devices, Gate and Base drive circuits - Preliminary design considerations, Temperature control of power devices, Heat sink design, and Design of Magnetic components.

- **DC-DC CONVERTERS** **(10 Hours)**

  Buck converter, Boost converter, Buck–Boost converters, CUK converter, Fly-back converter, Forward converter, Push–pull converter, Full bridge and Half bridge converters, Design considerations and comparison.

- **INVERTERS** **(12 Hours)**

  Review of single phase bridge inverters, 3-phase bridge inverters, Pulse width modulated inverters, 1-pulse and multi pulse modulation, Sinusoidal PWM, Space Vector PWM, Reduction of harmonics – Selective Harmonic Elimination Technique.

- **LINE COMMUTATED CONVERTERS** **(08 Hours)**

  Principle of phase control, Review of single phase converters, 3 phase half and fully controlled converters, 12–pulse converter, Dual converters.

- **AC VOLTAGE CONTROLLERS** **(02 Hours)**

  Single phase AC voltage controllers, 3–phase AC voltage controllers.

Total Hours: 42

BOOKS RECOMMENDED:

1. Rashid, M. H., "Power Electronics Circuits, Devices, and Applications, Prentice-Hall of India Pvt. Ltd., New Delhi, 2nd edition, 1999.
2. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics Converters, Applications, and Design”, John Willey & Sons, Inc., 2nd Edition, 1995.
3. Agrawal, J. P., "Power electronic systems: Theory and design" Addison Wesley Longman (Singapore) Pte. Ltd. New Delhi, 2001.
4. Erickson Robert W., Maksimovic Dragan, "Fundamentals of Power Electronics", Kluwer Academic Publishers Group (Netherlands), 2001.
5. A. Pressman, “Switching Power Supply Design”, McGraw-Hill, 1998.

M. Tech. (Electrical), Semester – I	L	T	P	C
EL603: MODELING OF ELECTRICAL MACHINES AND DC DRIVES	3	1	2	5

- **BASIC PRINCIPLE OF ELECTRICAL MACHINES** **(08 Hours)**

  Introduction, Magnetically coupled circuit, Electromagnetic energy conversion, machine winding and air gap EMF, winding inductance and voltage equations, equation of transformation, Reference-Frame Theory.

- **FUNDAMENTALS OF ELECTRIC DRIVES** **(08 Hours)**

  Introduction, Choice of Electrical Drives, Dynamics of Electrical Drives, Concept of Multi-quadrant operation, Components of load torques, Selection of motor power rating, Speed torque, speed control, Starting, Braking.

- **DC DRIVES** **(08 Hours)**

  Modeling, Rectifier fed DC drive, Chopper controlled DC drives, Close loop control of DC drive. Analysis of steady state and dynamic operation.

- **SYMMETRICAL INDUCTION MACHINES** **(10 Hours)**

  Introduction, voltage and torque equations in machine variables, voltage and torque equations in arbitrary reference frame, Analysis of steady state and dynamic operation.

- **SYNCHRONOUS MACHINES** **(08 Hours)**

  Introduction, voltage and torque equations in machine variables, voltage equations in rotor reference frame, Analysis of steady state and dynamic operation.

Total Hours: 42

BOOKS RECOMMENDED:

1. P. C. Krause, Oreg Wasynczuk, Scott D. Sudhoff P.C.Krause, Oreg Wasynczuk, Scott D. Sudhoff “Analysis of Electric Machinery and drive systems” , IEEE Press, 2002.
2. P. S. Bhimbra, “Generalised Theory of Electrical Machines “, Khanna Publications.
3. G. K. Dubey, “Fundamentals of Electrical Drives” Narosa, 2001.
4. Dubey .G.K. "Power semiconductor controlled Drives", Prentice Hall international, New Jersey, 1989.
5. R. Krishnan, “Electric motor drives Modeling, Analysis and Control” PHI-India, 2005 .

M. Tech. (Electrical), Semester –II	L	T	P	C
EL605: DIGITAL SIGNAL PROCESSING	**3**	**0**	**2**	**4**

- **INTRODUCTION** **(08 Hours)**

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

- **DISCRETE TIME SIGNALS AND SYSTEMS** **(10 Hours)**

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

- **DISCRETE AND FAST FOURIER TRANSFORMS** **(10 Hours)**

  Frequency domain sampling, proportion of DFT, efficient computation of DFT : FFT algorithms, Quantization effects in the computation of the DFT.

- **DIGITAL FILTERS** **(08 Hours)**

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

- **APPLICATIONS OF DSP** **(06 Hours)**

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

Total Hours: 42

BOOKS RECOMMENDED:

1. Proakis-Manolakis, Digital signal Processing, 3rd edition, PHI, 2000.
2. Oppenheim-Schetor, Discrete time signal processing, 2nd edition, Prectice Hall, 1997.
3. Rabiner-Gold, Theory & application of digital signal processing, PHI, 1992.
4. Sanjit Mitra, Digital Signal processing, McGraw-Hill Science/Engineering/Math; 3 edition, 2005.
5. Andy Bateman and Iain Paterson-Stephens, "The DSP Handbook: Algorithms, Applications and Design Techniques", Prentice Hall PTR, 2002.

M. Tech. (Electrical), Semester – I	L	T	P	C
EL607: FUNDAMENTALS OF SYSTEM THEORY	**3**	**0**	**0**	**3**

- **LINEAR ALGEBRA** **(20 Hours)**

  Vector spaces, Basis, Operator, range of the linear operator, null space, rank, nullity, rank-nullity theorem, matrix representation of the linear operator in the bases, orthogonal bases, Inner product spaces, Holder inequality, Cauchy-Schwartz inequality, triangular inequality, Minkowski inequality, best approximation theorem , orthogonal projection lemma, Gram- Schmidtt orthogonalization, Characteristics polynomial, minimal polynomial, eigen value and eigen vector, Diagonal form, Triangular form, Caley- Hamilton Theorem.

- **SYSTEM THEORY** **(22 Hours)**

  Introduction to Z transformation ,bilateral and unilateral Z transformation, Z transformation of the important signals, Solving Discrete LTI system using Z transformation, Pulse transfer function, Phase space analysis of the discrete LTI system, Jury Stability criterion , Schur-Cohn test, Bilinear transformation applied with Routh's stability criterion. Conservative system, Controllability, Obsrvability, Observer Design, Diaphantile equation, Full order, reduced order, minimum order observer, Gopinath Observer, Luenberger Observer.

Total Hours: 42

BOOKS RECOMMENDED:

1. Kenneth Hoffmann And Ray Kunze**, "**Linear Algebra**",** PHI India limited, 1971.
2. K. Ogata, "Discrete-Time Control Systems", Prentice Hall; 2nd edition, 1995.
3. Allen V. Oppenheim, S. Willsky, with S. Hamid Navab ''Signals and systems" Prentice Hall; 2nd edition, 1996.
4. K. Ogata, "Modern Control Engineering", 3rd Edition, PHI India limited, 2001.
5. I. J. Nagrath and M. Gopal, "Control System Engineering", Anshan Publishers; 5th edition, 2008.

M. Tech. (Electrical), Semester – I	L	T	P	C
EL609: INSTRUMENTATION FOR DRIVES	**2**	**0**	**2**	**3**

- **TRANSDUCERS FOR DRIVES** **(06 Hours)**
  Current, voltage, speed :incremental and absolute encoders, revolvers, torque sensors

- **DIGITAL MEASUREMENT TECHNICS FOR DRIVES** **(08 Hours)**
  Digital techniques of measurement of voltage, current, power, energy, speed and position and direction of rotation

- **SIGNAL CONDITIONING, DATA ACQUISITION AND CONVERSION** **(06 Hours)**
  Instrumentation amplifiers, isolation amplifiers, opto-couplers, sample and hold circuits, V/f and f/V converters, A/D and D/A converters, data acquisition systems,

- **EMI & EMC** **(08 Hours)**
  Introduction, causes of EMI, interference coupling mechanism, basics of circuit layout and grounding, concepts of interfaces, filtering and shielding. Safety: Introduction, electrical hazards, hazardous areas and classification, non-hazardous areas, enclosures – NEMA types, fuses and circuit breakers. Protection methods: Purging, explosion proofing and intrinsic safety.

Total Hours: 28

BOOKS RECOMMENDED:

1. Helfrick – Cooper, Modern electric instrumentation and measurement technique, PHI 1994.
2. T.S. Rathore, Digital measurement techniques, Narosa publishing House, 1996.
3. Rangan, Sanna, mani, Instrumentation devices & systems, TMH 1997.
4. Golding and Widdis, “Electrical measurements & Measuring instruments”, Wheeler books, 5th edition
5. Doebelin E.O, “Measurement Systems - Application and Design”, Fourth edition, McGraw-Hill, New York, 1992.

M. Tech. (Electrical), Semester –II	L	T	P	C
EL611: EMBEDDED SYSTEMS	**2**	**0**	**2**	**3**

- **INTRODUCTION TO EMBEDDED SYSTEMS** **(06 Hours)**

  Embedded systems description, definition, design considerations & requirements, embedded processor selection & tradeoffs, embedded design life cycle, product specifications, hardware/software partitioning, Co-Design concept.

- **EMBEDDED SOFTWARE ARCHITECTURE** **(08 Hours)**

  Concept of real time systems, concept of real-time task scheduling, scheduling methods, and introduction to real time operating systems (RTOS).

- **RTOS** **(08 Hours)**

  Foreground and bade ground process, task and task state, Semapheres and shared data, multitasking situations, Scheduler, static and dynamic priority, message queens, timer function, memory management ISR in RTOS, Embedded system design using RTOS.

- **APPLICATIONS OF EMBEDDED SYSTEMS** **(06 Hours)**

  Measurement of analog and electrical variables, control of electrical devices, user interface in embedded systems, data communication in embedded systems.

Total Hours: 28

BOOKS RECOMMENDED:

1. David E. Simon, “An Embedded Software Primer” Addision Wesley Pearson Education, 1999.
2. Jean J. Labrosse “Embedded system building Blocks”, , R&D Books, 1996.
3. Rajib Mall, “Real-Time Systems Theory and Practice”, Pearson Education, 2001.
4. Barnett & others, “Embedded C Programming and Microchip PIC”, Thomson Learning Inc. , 1st Edition
5. Jack Ganssle, "Embedded Systems", Newnes Edition, 2007.

M. Tech. (Electrical), Semester –II	L	T	P	C
EL613: POWER QUALITY ISSUES AND MANAGEMENT	**2**	**0**	**2**	**3**

- **POWER QUALITY** **(06 Hours)**

  Origin of power quality variation & events, power quality indices, causes and effects of power quality disturbances, Characterization of power quality events & event classification. Power quality measuring instruments, Analysis of Power outages, unbalance, distortions, voltage sag, flickers & load balancing.

- **PROCESSING OF STATIONARY & NON-STATIONARY SIGNALS** **(08 Hours)**

  Stationary signals: Overview of analysis methods, frequency domain analysis and signal transformation, estimation of harmonics & inter-harmonics.
  Non –stationary signals: Power quality data analysis methods, discrete STFT for analyzing time –evolving signal components, wavelet transform, block–based modeling.

- **POWER FACTOR CORRECTION & MITIGATION OF HARMONICS** **(08 Hours)**

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

- **CUSTOM POWER DEVICES** **(06 Hours)**

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

Total Hours: 28

BOOKS RECOMMENDED:

1. Bollen Math H.J., GU Irene Y.H.," Signal Processing of Power Quality Disturbances", Wilely Interscience Publication (IEEE Press),2006
2. Fuchs E.F., Masoum Mohammad A.S, "Power Quality in Power Systems and Electrical Machines", Elsevier Academic Press,2008
3. Bollen Math H.J," Understanding Power quality Problems: Voltage Sags and Interruptions", IEEE Press (Standard Publishers Distributors), 2001.
4. Ghosh A. ,Ledwich G. "Power quality enhancement using Custom Power Devices", Kluwer academic publication-Boston ,2002
5. Wakileh George J. "Power System Harmonics: Fundamentals, analysis and filter Design, "Springer, (first Indian reprint) 2007.

M. Tech. (Electrical), Semester –II	L	T	P	C
EL615: NEURAL NETWORK AND FUZZY LOGIC	**2**	**0**	**2**	**3**

- **INTRODUCTION TO NEURAL NETWORKS** **(04 Hours)**

  Introduction - biological neurons - Artificial neurons - activation function - learning rules - feed forward , Linear Filters, networks - supervised learning - Perceptron Architecture - adaline - madaline - back propagation networks - learning factors - linear separability - Hopfield network - discrete Hopfield networks,

- **ARCHITECTURE – TYPES** **(06 Hours)**

  Recurrent auto association memory - bi-directional associative memory - temporal associative memory - Boltzmann machine Hamming networks - self - organising feature maps - adaptive resonance theory network - Instar - Outsar model - counter propagation network - radial basis function networks

- **INTRODUCTION TO FUZZY SETS AND SYSTEMS** **(06 Hours)**

  Introduction , Conventional Control System Design, Fuzzy Control System Design
  Fuzzy Control: The Basics, General Fuzzy Systems, Simulation of Fuzzy Control Systems
  Real-Time Implementation Issues,

- **NONLINEAR ANALYSIS AND FUZZY IDENTIFICATION AND ESTIMATION** **(06 Hours)**

  Parameterized Fuzzy Controllers, Lyapunov Stability Analysis,
  Fuzzy Identification and Estimation, Fitting Functions to Data, Least Squares Methods, Gradient Methods, Clustering Methods

- **ADAPTIVE FUZZY AND FUZZY SUPERVISORY CONTROL** **(06 Hours)**

  Fuzzy Model Reference Learning Control (FMRLC), Indirect Adaptive Fuzzy Control 394
  Fuzzy Supervisory Control: Supervision of Conventional Controllers, Supervision of Fuzzy Controller

Total Hours: 28

BOOKS RECOMMENDED:

1. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill International Edition, USA, 1997.
2. Kevin M. Passino, Stephen Yurkovich, “Fuzzy Control” Addison Wesley Longman, 1998.
3. Lawrence Fausatt, "Fundamentals of neural networks", Prentice Hall of India, New Delhi, 1994.
4. Bart kosko, " Neural Networks and Fuzzy Systems", Prentice Hall of India, New Delhi, 1994.
5. S. Rajashekaran and G.A. Vijayalksmi, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications", Prentice-Hall of India Pvt. Ltd, 2004.

M. Tech. (Electrical), Semester – I	L	T	P	C
EL617: MICROCONTROLLER BASED SYSTEM DESIGN	**2**	**0**	**2**	**3**

- **REVIEW OF 8051 ARCHITECTURE** **(08 Hours)**
  General purpose registers, on-chip RAM, timers-counters, special function registers, 8051 interrupt system, input/output ports and circuits, UART, concept of SPI & I2C serial interface, programmable counter array (PCA) and different modes of operation, watchdog timers.

- **INTRODUCTION TO EMBEDDED 'C' PROGRAMMING** **(06 Hours)**
  Variables and constants, storage classes, enumerations and definitions, I/O operations, control statements, functions, pointers and arrays, structure and unions, interrupt service routines.

- **INTERFACING AND PROGRAMMING OF 8051 WITH EXTERNAL HARDWARE** **(10 Hours)**
  External memory, Serial and Parallel ADC / DAC, matrix keyboard, LCD, 7 segment display.

- **INTRODUCTION TO HIGH END 8051 CONTROLLER** **(04 Hours)**
  32-Bit Arm 7 and Cortex M-3 core, Harvard and Von-Neuman Architecture, AHB and Bus Matrix, Register Structure

Total Hours: 28

BOOKS RECOMMENDED:

1. Kenneth J. Ayala, "The 8051 Microcontroller", Penram International 3rd edition, 1996.
2. M. Mazidi and others, "The 8051 Microcontroller and Embedded Systems", PRENTICE Hall Of India, 3rd Edition, 2001.
3. Datasheet of SILABS C8051F12X
4. Subrata Ghoshal, "Embedded systems and Robots", Cengage Learning publication, 2001.
5. Barnett, O'cull, Cox, "Embedded C Programming and the Microchip PIC", Cengage Learning publication.

M. Tech. (Electrical), Semester – II	L	T	P	C
EL602: POWER ELECTRONICS – II	**3**	**1**	**2**	**5**

- **UNITY POWER FACTOR CONVERSION** **(08 Hours)**
  Topologies, Steady-sate Analysis, Dynamic Analysis, Modeling and Applications.

- **RESONANT CONVERTER** **(12 Hours)**
  Introduction, Classification, Basic Resonant Circuit Concepts, Load Resonant Converter, Resonant Switch Converter, Zero Voltage and Zero Current Switching, Clamped Voltage Topologies, Resonant DC link Inverter, High Frequency Link Integral Half Cycle Converters.

- **MULTI LELEL CONVERTERS** **(10 Hours)**
  Principle, Topologies, Control and applications.

- **OTHER ADVANCED CONVERTERS** **(06 Hours)**
  Multi-pulse Converters, Matrix Converters, applications.

- **DESIGN CONSIDERATIONS** **(06 Hours)**
  Design and selection of magnetic components, inductor, high-frequency transformers, line and EMI filters.

Total Hours: 42

BOOKS RECOMMENDED:

1. Rashid, M. H., "Power Electronics Handbook", Elsevier Academic Press, 2001.
2. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics Converters, Applications, and Design”, John Willey & Sons, Inc., 2nd Edition, 1995.
3. Agrawal, J. P., "Power electronic systems: Theory and design" Addison Wesley Longman (Singapore) Pte. Ltd. New Delhi, 2001.
4. Rashid, M. H., "Introduction to PSpice Using OrCAD for Circuits and Electronics, Prentice-Hall of India Pvt. Ltd., New Delhi, Eastern Economy Edition, Third Edition 2006.
5. Joseph Vithayathil, "Power Electronics: Principles and Applications", Mcgraw-Hill, 1995.

M. Tech. (Electrical), Semester – II	L	T	P	C
EL604: AC DRIVES	3	1	2	5

- **INDUCTION MOTOR DRIVES** **(22 Hours)**

  Introduction, Review of three phase I.M. analysis and performance, Analysis of I.M. fed from Non-sinusoidal supply voltage, Stator voltage control, V/f controlled induction motors, Slip power recovery, field oriented control, direct torque and flux control, CSI fed induction motor drives, Applications.

- **SYNCHRONOUS MOTOR DRIVES** **(20 Hours)**

  Introduction, Sinusoidal SPM machine drives, synchronous reluctance machine drives, Trapezoidal SPM machine drive, wound field synchronous motor drive, Load-commutated Synchronous Motor Drives, Model of PMSM, Vector controlled PMSM drive, UPF control, torque angle control, optimum torque per ampere control.

Total Hours: 42

BOOKS RECOMMENDED:

1. Dubey .G.K. "Power semiconductor controlled Drives", Prentice Hall international, New Jersey, 1989.
2. R. Krishnan,, " Electric motor drives Modeling, Analysis and Control" PHI-India, 2005 .
3. B.K.Bose, "Modern Power Electronics and AC drives" Pearson Education Asia, 2003.
4. Dewan, S. Slemon B., Straughen, A. G.R., "Power Semiconductor drives", John Wiley and Sons, NewYork 1984.
5. Rashid, M. H., "Power Electronics Handbook", Elsevier Academic Press, 2001.

M. Tech. (Electrical), Semester – II	L	T	P	C
EL606: INTRODUCTION TO 32-BIT DIGITAL SIGNAL CONTROLLER	**3**	**0**	**2**	**4**

- **INTRODUCTION** **(12 Hours)**
  Hard ware architecture, on chip peripherals, Memory systems and registers, interrupt processing

- **EMBEDDED C PROGRAMMING** **(16 Hours)**
  Embedded 'C' programming for 32-bit controllers, Introduction to IDE, Registers and variables, declarations and mapping, Interrupt functions in 'C', Programming for peripherals like DAC/ADC, PWM Unit, Timers, SPI, UART, I2C Protocols, Software and Hardware debugging techniques

- **APPLICATION** **(08 Hours)**
  Application of 32 bit controller in power electronics and control

- **ADVANCED TOPICS** **(06 Hours)**
  Introduction to PLL and FPGA

Total Hours: 42

BOOKS RECOMMENDED:

1. Trevor Martin, "The Insider's Guide To The Philips ARM7-Based Microcontrollers", Published by Hitex (UK) Ltd., April 2005.
2. Joseph Yiu, "The Definite Guide to cortex –M3", Elsevier publication, 2007.
3. Andrew & Sloss, "Arm System Development Guide", Elsevier Publication, 2007.
4. Datasheet and user manual of TI, Microchip range of digital signal controllers.
5. Barnett, O'cull, Cox, "Embedded C Programming and the Microchip PIC", Cengage Learning publication.

M. Tech. (Electrical), Semester –II	L	T	P	C
EL608: APPLICATIONS OF POWER ELECTRONICS TO POWER SYSTEMS	**3**	**0**	**0**	**3**

- **INTRODUCTION** **(06 Hours)**

  Voltage source inverter (VSI), Synchronous reference frame theory, Instantaneous reactive power theory, Introduction to Active filter.

- **REACTIVE POWER COMPENSATION** **(11 Hours)**

  Analysis of uncompensated AC line, Passive reactive power compensation, Compensation by a series capacitor connected at the mid point of the line, Effect on Power Transfer capacity, Compensation by STATCOM and SSSC, Synchronous condenser, Saturated reactor, Thyristor-controlled reactor (TCR), Thyristor controlled transformer (TCT), Fixed capacitor-Thyristor controlled reactor (FC-TCR), Thyristor switched capacitor (TSC), Thyristor-switched capacitor-thyristor controlled reactor (TSC-TCR).

- **STATIC VAR COMPENSATORS** **(08 Hours)**

  Analysis of SVC, Configuration of SVC, SVC Controller, Modelling of SVC, Voltage regulator Design, Voltage control by the SVC, Advantages of the slope in the SVC Dynamic Characteristic, Influence of the SVC on System Voltage, Design of the SVC Voltage Regulator.

- **STATIC SYNCHRONOUS COMPENSATOR (STATCOM)** **(06 Hours)**

  Principle of operation, Analysis of a three phase six pulse STATCOM, Multi-pulse converters, Applications of STATCOM.

- **THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND STATIC SYNCHRONOUS SERIES COMPENSATOR (SSSC)** **(08 Hours)**

  Principle of operation, Analysis and control, Applications.

- **UNIFIED POWER FLOW CONTROLLER (UPFC)** **(03 Hours)**

  Operation of UPFC, Applications of UPFC.

Total Hours: 42

BOOKS RECOMMENDED:

1. Mathur R. Mohan & Varma R. K “Thyristor–based FACTS controllers for electrical transmission system”, Wiley Inter-Science, 2002.
2. Padiyar K.R. “FACTS controller in power transmission and distribution”, New Age international, Edition 1st 2007.
3. N.G. Hingorani , “Understanding FACTS”, IEEE Press 2001.
4. Acha E., Agelidis V.G.,Anaya-Lara O., T.J.E. Miller, “Power Electronics Control in Electrical System”, Newnes Power Engineering Series,2002.
5. Vijay K. Sood, "HVDC and FACTS Controllers: Applications of Static Converters in Power Systems", Springer; 1 edition, 2004.

M. Tech. (Electrical), Semester – II	L	T	P	C
EL610: SPECIAL MACHINES	**2**	**0**	**2**	**3**

- **STEPPING MOTORS** **(06 Hours)**

  Constructional features, principle of operation, Types of stepper motors: VR Stepper motor, PM stepper motor, Hybrid stepper motor, torque production in VR stepper motor, modes of excitation, Dynamic characteristics, Drive systems and circuit for open loop control, Closed loop control of stepping motor.

- **SWITCHED RELUCTANCE MOTORS** **(06 Hours)**

  Constructional features, principle of operation, Torque equation, Power controllers, speed torque characteristics Switched reluctance motor, Power controllers for Switched Reluctance Motors

- **PERMANENT MAGNET BRUSHLESS DC MOTORS** **(08 Hours)**

  Commutation in DC motors, difference between mechanical and electronic Commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square - Wave permanent magnet brushless motor drives, torque and EMF equation, torque - speed characteristics of Permanent Magnet Brush less DC Motors - controllers PM DC Motor

- **MACHINE DESIGN** **(08 Hours)**

  Fundamentals of machine design, Design philosophy, Materials, Stresses in machines, Machine design using FEM package.

Total Hours: 28

BOOKS RECOMMENDED:

1. Miller. T. J. E., "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.
2. Kenjo. T and Nagamori. S, "Permanent Magnet and Brushless DC Motors", Clarendon Press, Oxford, 1989.
3. Kenjo. T, "Stepping Motors and their Microprocessor Control", Clarendon Press, Oxford, 1989.
4. Krishnan R, "Switched Reluctance Motor Drives", Modelling, Simulation, Analysis, Design and applications, CRC press, 2006.
5. Hughes, "Electric Motors & Drives", Newnes; 3rd edition, 2005.

M. Tech. (Electrical), Semester –II	L	T	P	C
EL612: PLC AND DCS	**2**	**0**	**2**	**3**

- **INTRODUCTION TO AN INDUSTRIAL AUTOMATION** **(06 Hours)**

  Need for an industrial automation, PLC definition, overview of PLC systems, input/output modules, power supplies and isolations. General PLC programming procedures, programming on-off inputs/ outputs.

- **PLC PROGRAMMING INSTRUCTIONS** **(08 Hours)**

  Bit logic, data move, timers, counters, compare, convert instructions. Arithmetic instructions. Analog value processing. Networking of PLC, PLC-PID functions, PLC installation, troubleshooting and maintenance. Design of interlocks and alarms using PLC, creating ladder diagrams from process control descriptions.

- **INTERFACE AND BACKPLANE BUS STANDARDS FOR INSTRUMENTATION SYSTEMS, FIELD BUS SYSTEMS** **(06 Hours)**

  Foundation field bus, profibus and other field level protocols. HART protocol: Method of operation, structure, operating conditions and applications. Smart transmitters, smart valves and smart actuators.

- **DISTRIBUTED CONTROL SYSTEMS (DCS)** **(08 Hours)**

  Definition, Local Control Unit (LCU) architecture, LCU languages, LCU - Process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept - case studies in DCS, Data loggers, Data Acquisition Systems (DAS), Direct Digital Control (DDC).Supervisory Control And Data Acquisition Systems (SCADA), sampling considerations.

Total Hours: 28

BOOKS RECOMMENDED:

1. John W. Webb, Programmable controllers, Merrill publishing company, 1988.
2. Poporic Bhatkar, Distributed computer control for industrial equation, Marcel Dekker pub, 1990.
3. Liptak B. G., Process control handbook, Chilton book company,1995.
4. W. Bolton, "Programmable Logic Controllers", Newnes; 4 edition, 2006.
5. Kevin Collins, "PLC Programming for Industrial Automation", Exposure Publishing, 2007.

M. Tech. (Electrical), Semester – II	L	T	P	C
EL614: HVDC (HIGH VOLTAGE DC TRANSMISSION)	**2**	**0**	**2**	**3**

- **INTRODUCTION** **(04 Hours)**

  Introduction to AC and DC Transmission - application of DC Transmission - description of DC transmission - DC system components and their functions - modern trends in DC Transmission.

- **CONVERTER** **(08 Hours)**

  Pulse Number - Converter configuration - analysis of Graetz circuit - converter bridge characteristics - characteristics of 12 Pulse converters.

- **HVDC CONTROLLERS** **(08 Hours)**

  General principle of DC link control - converter control characteristics - system control hierarchy - firing angle control - current and extinction angle control - Dc link power control - high level controllers.

- **FILTERS** **(04 Hours)**

  Introduction to harmonics - generation of harmonics - design of AC filters - DC filters - carrier frequency and RI noise.

- **PROTECTION** **(04 Hours)**

  Basics of protection - DC reactors - voltage and current oscillations - circuit breakers - over voltage protection - switching surges - lightning surges - lightning arresters for DC systems.

Total Hours: 28

BOOKS RECOMMENDED:

1. Kimbark, "Direct Current Transmission - Vol. I", John Wiley and Sons Inc., New York, 1971.
2. Padiyar. K. R., "HVDC Power Transmission Systems", Wiley Eastern Limited, New Delhi, 2000.
3. Arrillaga. J, "High Voltage Direct Current Transmission", Peter Peregrines, London, 1983.
4. Vijay K. Sood, "HVDC and FACTS Controllers: Applications of Static Converters in Power Systems", Springer; 1 edition, 2004.
5. Chan-Ki Kim, Vijay K. Sood, Gil-Soo Jang, Seong-Joo Lim, and Seok-Jin Lee, "HVDC Transmission: Power Conversions Applications in Power Systems", Wiley, illustrated edition, 2009.

M. Tech. (Electrical), Semester –II	L	T	P	C
EL616: WIND & SOLAR ENERGY POWER CONVERSION	**2**	**0**	**2**	**3**

- **WIND ENERGY** **(12 Hours)**

  Introduction, Basic principles of wind energy conversion, wind data and energy estimation, site selection considerations, types of wind generators, basic components of wind electric conversion systems, power electronics interface with wind generators, energy storage, applications of wind energy, inter connected systems.

- **SOLAR ENERGY** **(10 Hours)**

  PV Characteristics, Power Electronics Interface for solar energy, Max Power Tracking algorithm, load estimation, selection of inverter, battery sizing, array sizing, wiring for SPV system.

- **OPTIMISATION TECHNIQUE** **(06 Hours)**

  Wind / Solar PV integrated systems design, Grid synchronized inverter system.

Total Hours: 28

BOOKS RECOMMENDED:

1. S. P. Sukhatme, “Solar Energy - Principles of thermal collection and storage”, TMH, 2008.
2. Thomas Ackermann, “Wind Power in Power System”, John Willey &Sons, 2005.
3. J. Twidell and T. Weir, “Renewable Energy Resources”, E & F N Spon Ltd, London, 1999.
4. Daniel, Hunt V, "Wind Power - A Handbook of WECS", Van Nostrend Co., New York, 1981.
5. Gary L. Johnson, "Wind Energy Systems", Prentice Hall Inc., 1985.

M. Tech. (Electrical), Semester – I	L	T	P	C
EL618: MODERN CONTROL SYSTEM	**2**	**0**	**2**	**3**

- **NONLINEAR CONTROL SYSTEM** **(06 Hours)**

  Introduction to nonlinear systems , describing function analysis, stability of the equilibrium point in Lyapunov sense, asymptotic stability of the equilibrium point, and limit cycles, qualitative analysis of the non-linear autonomous and non-autonomous systems, phase-plane analysis of linear control systems, phase-plane analysis of' non-linear control systems, minimum time trajectory, optimum switching curve.

- **OPTIMAL CONTROL SYSTEM** **(08 Hours)**

  Calculus of variation, fixed-end-point problem, free-end-point problem and constrained variation problem, optimal control Problems, the Hamiltonian formulation, a linear regulator problem, Pontryagin's, Minimum time problems.

- **ADAPTIVE CONTROL SYSTEM** **(08 Hours)**

  Model reference adaptive systems, MIT rule, MKY lemma, self tuning regulators, applications of adaptive control in orbiting satellite, autopilot for surface to air missile, robotic manipulators.

- **ESTIMATION THEORY WITH APPLICATION TO CONTROL** **(06 Hours)**

  Random variable, conditional probability density, conditional expectation, auto correlation, cross correlation Power spectrum density, stochastic resonance, linear minimum variance estimators, Wiener-Hopf equation, orthogonal projection, Wiener filter, Kalman filter, stationary Kalman filters, extended Kalman filter, Ricatti equation, Degenerate Ricatti equation.

Total Hours: 28

BOOKS RECOMMENDED:

1. K. Ogata, “Modern Control Engineering”, 3rd Edition, PHI India limited, 2001.
2. Donald E. Kirk, “Optimal Control: an introduction”, Dover Publications, 2006.
3. I. D. landau, “Adaptive Control (communications and control engineering)”, Springer; 1 edition, 1999.
4. A. P. sage and PL Melsa, “Estimation theory with applications to communication and control”, McGraw Hill: New York (1971).
5. A. Papoulis, “Probability, Random variables, Stochastic processes” McGraw-Hill, 3rd edition, 1991.

EL701 SEMINAR
M.TECH. II (3rd SEMESTER)

- Seminar Work will be on the basis on the new development in the area of power electronics and allied fields.

EL703 DISSERTATION PRELIMINARY
M.TECH. II (3rd SEMESTER)

- Dissertation Work will be on the basis on the new development in the area of power electronics and allied fields.

EL702 DISSERTATION
M.TECH. II (4th SEMESTER)

- Dissertation work will be on the basis on the new development in the area of power electronics and allied fields.