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)

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Elective I
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M. Tech. (Electrical), Semester – I

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- **REVIEW OF POWER SEMICONDUCTOR DEVICES**
  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**
  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**
  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**
  Principle of phase control, Review of single phase converters, 3 phase half and fully controlled converters, 12–pulse converter, Dual converters.

- **AC VOLTAGE CONTROLLERS**
  Single phase AC voltage controllers, 3–phase AC voltage controllers.

  **Total Hours: 42**

**BOOKS RECOMMENDED:**

# EL603: MODELING OF ELECTRICAL MACHINES AND DC DRIVES

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### 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:

M. Tech. (Electrical), Semester –II

EL605: DIGITAL SIGNAL PROCESSING

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- **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:**

**M. Tech. (Electrical), Semester – I**

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- **LINEAR ALGEBRA** (20 Hours)

- **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, Observability, Observer Design, Diaphantile equation, Full order, reduced order, minimum order observer, Gopinath Observer, Luenberger Observer.

**Total Hours: 42**

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

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

- **SIGNAL CONDITIONING, DATA ACQUISITION AND CONVERSION**
  - 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**

**Total Hours: 28**

**BOOKS RECOMMENDED:**

1. Helfrick – Cooper, Modern electric instrumentation and measurement technique, PHI 1994.
### M. Tech. (Electrical), Semester –II

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- **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:**

M. Tech. (Electrical), Semester –II

EL613: POWER QUALITY ISSUES AND MANAGEMENT

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- **POWER QUALITY** (06 Hours)

- **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:**

### INTRODUCTION TO NEURAL NETWORKS (04 Hours)

### ARCHITECTURE – TYPES (06 Hours)

### 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
- Fuzzy Supervisory Control: Supervision of Conventional Controllers, Supervision of Fuzzy Controller

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**BOOKS RECOMMENDED:**

M. Tech. (Electrical), Semester – I  

EL617: MICROCONTROLLER BASED SYSTEM DESIGN  

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- **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:**

3. Datasheet of SILABS C8051F12X
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<td>EL602: POWER ELECTRONICS – II</td>
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- **UNITY POWER FACTOR CONVERSION** (08 Hours)
  Topologies, Steady-state Analysis, Dynamic Analysis, Modeling and Applications.

- **RESONANT CONVERTER** (12 Hours)

- **MULTI LEVEL 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:**

M. Tech. (Electrical), Semester – II
EL604: AC DRIVES

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

- **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.

**BOOKS RECOMMENDED:**

# EL606: INTRODUCTION TO 32-BIT DIGITAL SIGNAL CONTROLLER

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- **INTRODUCTION**
  - Hardware architecture, on chip peripherals, Memory systems and registers, interrupt processing

- **EMBEDDED C PROGRAMMING**
  - 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**
  - Application of 32 bit controller in power electronics and control

- **ADVANCED TOPICS**
  - Introduction to PLL and FPGA

Total Hours: 42

**BOOKS RECOMMENDED:**

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

REACTIVE POWER COMPENSATION
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, Thyrister-controlled reactor (TCR), Thyrister 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
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)
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)
Principle of operation, Analysis and control, Applications.

UNIFIED POWER FLOW CONTROLLER (UPFC)
Operation of UPFC, Applications of UPFC.

BOOKS RECOMMENDED:
M. Tech. (Electrical), Semester – II

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- **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:**

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)

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:

2. Poporic Bhatkar, Distributed computer control for industrial equation, Marcel Dekker pub, 1990.
M. Tech. (Electrical), Semester – II

EL614: HVDC (HIGH VOLTAGE DC TRANSMISSION)  

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- **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.

**BOOKS RECOMMENDED:**

M. Tech. (Electrical), Semester –II

EL616: WIND & SOLAR ENERGY POWER CONVERSION  |  L  |  T  |  P  |  C
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**BOOKS RECOMMENDED:**

M. Tech. (Electrical), Semester – I

EL618: MODERN CONTROL SYSTEM

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- **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)

**Total Hours: 28**

**BOOKS RECOMMENDED:**

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.