## FACULTY OF ENGINEERING

# Savitribai Phule Pune University

**Structure for the**

**T.E (Electronics Engineering)**

**(2015 Course)**

**(w.e.f . June 2017)**

# Savitribai Phule University of Pune, Pune

# Third Year Electronics Engineering (2015 Course)

**(With effect from Academic Year 2017-18)**

| Semester I | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Course** | **Teaching Scheme Hours / Week** | | | **Semester Examination Scheme of Marks** | | | | | | **Credits** | |
| | | **Theory** | **Tutorial** | **Practical** | **In-Sem** | **End-Sem** | **TW** | **PR** | **OR** | **Total** | **TH+TUT** | **PR/OR/TW** |
| 304201 | Power Electronics and Applications | 3 | | -- | 30 | 70 | -- | -- | -- | 100 | 3 | -- |
| 304202 | Instrumentation Systems | 3 | -- | -- | 30 | 70 | -- | -- | -- | 100 | 3 | -- |
| 304203 | Electromagnetics and Wave propagation | 3 | 1 | -- | 30 | 70 | -- | -- | -- | 100 | 4 | -- |
| 304204 | Microcontrollers and Applications | 3 | -- | -- | 30 | 70 | -- | -- | -- | 100 | 3 | -- |
| 304205 | Data Communication | 3 | -- | -- | 30 | 70 | -- | -- | -- | 100 | 3 | -- |
| 304211 | Instrumentation and Power Electronics Lab | -- | -- | 4 | -- | -- | 50 | 50 | -- | 100 | -- | 2 |
| 304212 | Microcontroller and Data Communication Lab | -- | -- | 4 | -- | -- | 50 | 50 | -- | 100 | -- | 2 |
| 304213 | Electronics System Design Practice | 2 | -- | 2 | -- | -- | -- | -- | 50 | 50 | 2 | 1 |
| | **Audit Course 3** | -- | -- | -- | -- | -- | -- | -- | -- | -- | ---- | |
| | **Total** | 17 | 1 | 10 | 150 | 350 | 100 | 100 | 50 | 750 | 18 | 5 |
| | | | | | | | | | | **Total Credits** | **23** | |

# Third Year Electronics Engineering (2015 Course)

**(With effect from Academic Year 2017-18)**

| **Semester II** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Course** | **Teaching Scheme Hours / Week** | | | **Semester Examination Scheme of Marks** | | | | | | **Credit** | |
| | | **Theory** | **Tutorial** | **Practical** | **In-Sem** | **End-Sem** | **TW** | **PR** | **OR** | **Total** | **TH+TUT** | **PR /OR/TW** |
| 304206 | DSP and Applications | 3 | -- | -- | 30 | 70 | -- | -- | -- | 100 | 3 | -- |
| 304207 | Embedded Processors | 4 | -- | -- | 30 | 70 | -- | -- | -- | 100 | 4 | -- |
| 304208 | Business Management and Organization | 3 | -- | -- | 30 | 70 | -- | -- | -- | 100 | 3 | -- |
| 304209 | Fundamentals of HDL | 3 | -- | -- | 30 | 70 | -- | -- | -- | 100 | 3 | -- |
| 304210 | PLC and Applications | 3 | -- | -- | 30 | 70 | -- | -- | -- | 100 | 3 | -- |
| 304214 | Embedded and DSP Lab | -- | -- | 4 | -- | -- | 50 | 50 | -- | 100 | -- | 2 |
| 304215 | PLC and HDL Programming Lab | -- | -- | 4 | -- | -- | 50 | 50 | -- | 100 | -- | 2 |
| 304216 | Mini Project | 2 | -- | 2 | -- | -- | -- | -- | 50 | 100 | 2 | 1 |
| | **Audit Course 4** | -- | -- | -- | -- | -- | -- | -- | -- | -- | | |
| | **Total** | 18 | --- | 10 | 150 | 350 | 100 | 100 | 50 | 750 | 18 | 5 |
| | | | | | | | | | | **Total Credits** | **23** | |

**Power Electronics & Applications (304201)**
**Credits: TH-03**

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester Assessment: 30 Marks
End Semester Examination: 70 Marks

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**Course Objectives:**

- To understand construction, switching characteristics and protection of power devices
- To understand protection circuits and triggering circuits for power devices.
- To give an exposure to students of working & analysis of controlled rectifiers, inverters, choppers, AC voltage controllers for different loads.

**Course Outcomes:**

After successfully completing the course students will be able to

- Understand basic principle of power conversion.
- Design & implement a triggering / gate drive circuit for a power device
- Design & implement protection circuits for power devices.
- Understand, design & analyze different Power electronics converters.
- Utilize power converters in different industrial applications.

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**Perquisites:**

Three phase supply: 3 phase 3 wire connection, 3 phase 4 wire connection ,single phase supply, DC supply and their measurement, Power factor and its significance. **1L**

**Unit I: Overview of Power Electronics and Power Devices 8L**

**Power Electronic System:** Power Electronics Versus linear electronics, scope and applications, Interdisciplinary nature of power electronics, classification of power converters

**Power MOSFET:** Construction, Operation, Static characteristics, switching characteristics, Breakdown voltages, Safe Operating Area, applications **IGBT:** Construction, Operation, Steady state characteristics, Switching characteristics, Safe operating area, applications, Base drive circuits, for Power MOSFET / IGBT. **SCR:** Construction, Operation & characteristics, two transistor analogy, different ratings, **TRIAC:** Construction, Operation & characteristics, applications.

**Unit II: Gate drive circuits and Protection circuits for Power Devices 7L**

Gate drive Circuits for SCR/TRIAC: Need, requirements, Isolation of Gate and base drives using pulse transformers and opto-coupler, Synchronized UJT triggering for SCR, triggering of SCR/TRIAC using dedicated triggering ICs, TRIAC triggering using DIAC. Typical Gate drive circuits for Power MOSFET / IGBT**.** Microprocessor based control circuits for power electronics applications.

**Protection circuits for Power Devices:** Cooling and heat sinks. Snubber circuits, reverse recovery transients, supply and load side transients. Voltage protection by selenium diodes and MOVs. Current protections – fusing, fault current with AC source, fault current with DC source.

**Unit III: AC-DC power converters 7L**

Uncontrolled and controlled rectifiers need and applications Single phase Semi & Full converters for R, R-L loads, Concept of line & forced commutation, Effect of freewheeling diode, Performance parameters, Three phase Semi & Full converters for R and RL load. Design of Control circuit for single phase and three phase controlled rectifiers, Applications of controlled rectifiers.

**Unit IV: DC-AC Converters & AC Voltage Controller 7L**

**DC-AC Converters:** Single phase full bridge inverter for R & R-L loads, performance parameters, three phase voltage source inverter for balanced star R load. Variable frequency control of three phase inverters, Need of PWM inverters. Voltage control of Inverters using PWM, three phase PWM inverters. Design of control circuit design for three phase inverters, PWM ICs. **AC Voltage Controller:** Single phase AC voltage controller with R load.

**Unit V: DC-DC converters 7L**

DC-DC converters: Working principle of step down chopper for R-L load, control strategies. Performance parameters, Buck converter, Buck-Boost converter, 2-quadrant & 4-quadrant choppers, Applications of choppers, SMPS. Buck regulator e.g. TPS54160, Switching Regulator and characteristics of standard regulator ICs – TPS40200, Low Drop out (LDO) Regulators ICs-TPS 7A4901.

**Unit VI: Power Electronics Applications 6L**

HVDC transmission system. UPS: ON-line and OFF line UPS with battery AH, back up time, battery charger rating. Power Electronics in Battery Charging Applications, Power

Electronics in Induction heating, Electronic lamp ballast. Power Electronics for Electric drive applications: Overview of electric drive system, Classification of drives, Selection of power converters for different drive applications (introductory level only).

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**Text Books:**

1. M H Rashid, "Power Electronics – circuits, devices and applications", 3rd edition, Pearson Education.
2. Power Electronics, M.D. Singh & K.B.Khanchandani, TMH
3. Ned Mohan, T. Undeland & W. Robbins, "Power Electronics Converters applications and design" 2nd edition, John Willey & sons, Singapore

**Reference Books:**

1. P.C. Sen, "Modern Power Electronics", S Chand & Co New Delhi
2. Dr. P. S. Bimbhra, "Power Electronics", Khanna Publishers, Delhi. 6. Nagrath Kothari, "Electrical Machines", TMH.
3. U. R. Moorthi, "POWER ELECTRONICS, DEVICES, CIRCUITS & INDUSTRIAL APPLICATIONS" , Oxford University Press, New Delhi, 2005

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**Instrumentation Systems (304202)**
**Credits: TH-03**

| **Teaching Scheme:** | **Examination Scheme**: |
|---|---|
| Lectures: 3 Hrs/ Week | In Semester Assessment: 30 Marks |
| | End Semester Examination: 70 Marks |

**Course Objectives:**

- Explain the operation/working of different sensors
- To get fundamental knowledge of sensors and transducers and their operating principles, for measurement of mechanical parameters.
- To impart interdisciplinary knowledge regarding transducers, pneumatic actuators, hydraulic actuators.
- Describe advantages, disadvantages, and applications of limit switches, photoelectric sensors, inductive sensors, capacitive sensors, and ultrasonic sensors
- Transform a temperature reading among different scales.
- Explain the operation of pressure, flow, and level transducers in context with applications.
- Understand the concept of final control elements in various applications

**Course Outcomes:**

After successfully completing the course students will be able to:

- Applications and selection of sensors/transducers for particular application.
- Describe the various types of sensors including thermal, mechanical, electrical, electromechanical and optical sensors.
- Select appropriate transducers and instrumentation system components for a specific application.
- Design and development of temperature/pressure/flow etc measurement systems.
- Select appropriate Switches and final control elements for a specific application.

**Unit I : Fundamentals of Sensors & Transducer** **6L**

Definitions sensors & transducer, Classification of sensors & transducers, Sensor systems, Performance & Terminology: Range/Span, Errors & Accuracy, Non linearity, Dead band & saturation, output impedance, repeatability, reliability, Sensitivity, Resolution, Frequency response, Response time, Calibration. Advantages, disadvantages & applications of sensors & transducers, Block diagram & description of Instrumentation system,

**Unit II: Temperature & Chemical sensors 6L**

**Temperature**: Resistance temperature detectors, thermistors, thermocouples and pyrometers. Acoustics sensors, Semiconductor temperature sensing – LM75 block diagram, temperature compensated integrated phototransistor, Signal conditioning circuit for RTD & Thermocouple, Humidity Sensor. Interfacing technique of Temperature sensors with microcontroller.
**Chemical sensors**: classes of chemical sensors, Characteristics of chemical sensors, biochemical sensors, electronics noses.

**Unit III**: **Flow and Level Sensing 6L**

**Flow**: Bernoulli Equation, Differential head type flow meters (orifice, venture tube and flow nozzle), Pitot static tube, Variable area type flow meter – rotameter, vortex shedding, electromagnetic, ultrasonic flow meters. open channel flow measurement – anemometers.
**Level**: Float, DP Cell, chain balanced float type, Ultrasonic, Capacitance probe type, Hydrostatic pressure and Nuclear level detection techniques.

**Unit IV**: **Motion, Light & Radiation Detectors 6L**

**Motion detectors**: Ultrasonic, capacitive detectors, LVDT, optoelectronics motion sensors, Acceleration sensors – Accelerometer characteristics, capacitive accelerometers, Piezoelectric accelerometer, Piezoresistive accelerometer, thermal accelerometer. Tachometers – Optical tachometer, rotary detectors.
**Light & Radiation detectors** : Photo diodes, photo transistor, CCD, CMOS image sensors – advanced APD sensors, gas flame detectors, Radiation detectors – ionization detectors,

**Unit V** : **MEMS & Smart sensors 6L**
Magnetic field sensors – Hall effect and magneto-resistive elements (MRE), magneto-transistors, piezoelectric (PZT) sensors and actuators. Microelecromechanical systems (MEMS) - Bulk micromachining, micro-machined absolute pressure sensor, Surface
Micromachining-Hot wire anemometer micro-miniature temperature sensor, surface micro machined accelerometer and SMART sensors.

**Unit VI : Actuators and Final Control Elements 6L**
Pneumatic and hydraulic actuators- Directional control valves, Pressure control valves, Cylinders, Process control valves - Electrical actuators- Mechanical switches, Solid state switches, Solenoids, DC motors, AC motors and Stepper motors.

**Text Books**

1. W. Bolton; " Mechatronics, Electronic Control Systems in Mechanical and Electrical Engineering "; Pearson Education; 3rd Edition
2. William C. Dunn , "Introduction to Instrumentation, Sensors, and Process Control" , Artech House Sensors Library.

**Reference Books**

1. Curtis Johnson; " Process Control Instrumentation Technology "; Prentice Hall of India Pvt. Ltd.;7th Edition
2. Ernest O. Doebelin; "Measurement System Application and Design "; Mc-Graw Hill; 5th Edition
3. David G. Alciatore, Michael B Histand; " Introduction to Mechatronics and Measurement System "; Tata McGraw Hill
4. C.S. Rangan, G.R. Sarma, V.S.V. Mani; " Instrumentation Devices and Systems "; Tata McGraw Hill; 2nd Edition.

## Electromagnetics and Wave Propagation (304203)

**Credits: TH- 03+ TUT-01**

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| Lectures: 3 Hrs/ Week | In Semester Examination: 30 Marks |
| Tutorial: 1 Hr / Week | End Semester Examination: 70 Marks |

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**Course Objectives:**

- To study the basics of Electrostatics and Magnetostatics with their applications.
- To understand the Time Varying Fields and Maxwell's Equations.
- To interpret the given electromagnetic problem and solve it using Maxwell's Equations.
- To analyze the wave propagation in different media using wave equation**.**
- To study the effect of different parameters on wave propagation.

**Course Outcomes:**

After successfully completing this course, students will be able to

- Apply the basics of Electrostatics and Magnetostatics in different applications.
- Interpret the given electromagnetic problem and solve it using Maxwell's Equations.
- Formulate the wave equation and solve it for uniform plane wave in different media.
- Explain the effect of different parameters on wave propagation.

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**Unit I: Basic Electrostatics** **8L**

Coulomb's Law & Electric Field Intensity, Electric Field due to Point Charge & Continuous Charge Distributions, Electric Flux Density, Gauss's Law and its Applications, Divergence & Divergence Theorem, Electric Potential, Relationship between E & V, Potential Gradient, Electric Dipole and Flux Lines.

**Unit II: Applied Electrostatics** **8L**

Energy Density in Electrostatic Field, Current and Current Density, Continuity Equation, Polarization in Dielectrics, Capacitance, Parallel Plate, Spherical and Cylindrical Capacitors with Multiple Dielectrics, Boundary Conditions, Poisson's and Laplace's Equations, General Procedures for Solving Poisson's and Laplace's Equations, Application Note – Lightning.

**Unit III: Magnetostatics & Applications** **8L**

Biot-Savart's Law, Ampere's Circuit Law and its Applications, Magnetic Flux Density, Magnetic Scalar and Vector Potentials, Derivation of Biot-Savarts Law and Ampere's Law using Concept of Magnetic Vector Potential, Forces due to Magnetic Fields, Magnetic

Dipole, Classification of Magnetic Materials, Magnetic Boundary Conditions, Application Note – Magnetic Levitation.

**Unit IV: Time Varying Fields and Maxwell's Equations 8L**

Faraday's Law, Transformer and Motional Electromotive Forces, Displacement Current, Maxwell's Equations in Point Form and Integral Form, Time-Varying Potentials, Time Harmonic Fields, Maxwell Equations in Phasor Form, Boundary Conditions for Time varying Field.

**Unit V: Plane Waves 8L**

Wave Equation, Wave Propagation in Lossy Dielectrics, Plane Waves in Lossless Dielectrics, Free Space & Good Conductors, Electromagnetic Power and Poynting Theorem, Polarization of Wave: Linear, Circular & Elliptical, Reflection of a Plane Wave at Normal Incidence & Oblique Incidence.

**Unit VI: Wave Propagation 8L**

Fundamental Equation for Free-Space Propagation, Modes of Propagation: Ground, Sky & Space Wave Propagations, Structure of Atmosphere, Characteristics of Different Ionized Regions, Effect of Earth's Magnetic Field & Curvature on Wave Propagation, Virtual Height, MUF, Skip Distance, Multi-Hop Propagation, Duct Propagation, Characteristics of Wireless Channel: Fading, Multipath Delay Spread, Coherence Bandwidth and Coherence Time.

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**Text Books**

1. Matthew N. O. Sadiku, "Principles of Electromagnetics", 4th Edition, Oxford University Press.
2. K. D. Prasad, "Antenna & Wave Propagation", Satya Prakashan, New Delhi.

**Reference Books**

1. Edminister J. A, "Electromagnetics", Tata McGraw-Hill.
2. Hayt & Buck, "Engineering Electromagnetics", 7th Edition, Tata McGraw-Hill.
3. John D. Kraus, "Antenna & Wave Propagation", 4th Edition, McGraw Hill.
4. Vijay K. Garg, "Wireless Communications and Networking", Morgan Kaufmann Publishers, An Imprint of Elsevier, 2008.

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## Microcontrollers and Applications (304204)

**Credits: TH-03**

**Teaching Scheme:**
Lectures: 3 Hrs/ Week

**Examination Scheme:**
In Semester Assessment: 30 Marks
End Semester Examination: 70 Marks

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**Course Objectives:**

- To understand the applications of Microprocessors & Microcontrollers.
- To understand need of microcontrollers in embedded system.
- To understand architecture and features of typical Microcontroller.
- To learn interfacing of real world input and output devices
- To study various hardware & software tools for developing applications

**Course Outcomes:**

After successfully completing the course students will be able to

- Learn importance of microcontroller in designing embedded application
- Describe the 8051 & PIC18FXX microcontroller architectures and its feature.
- Develop interfacing to real world devices
- Learn use of hardware & software tools

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**UNIT I: Introduction to microcontroller Architecture 8L**

Microprocessor and microcontroller comparison, advantages & applications. Harward & Von Neumann architecture, RISC & CISC processors. Role of microcontroller in embedded system. Selection criteria of microcontroller.

Overview of MCS-51 architecture, Block diagram and explanation of 8051, Port structure, memory organization, Interrupt structure, timers and its modes, serial communication modes. Overview of Instruction set, Sample programs (assembly): Delay using Timer and interrupt, Programming Timer 0&1, Data transmission and reception using Serial port.

**Unit II: Interfacing-I 6L**

Software and Hardware tools for development of microcontroller based systems such as assemblers, compliers, IDE, Emulators, debuggers, programmers, development board, DSO, Logic Analyzer.

Interfacing LED with and without interrupt, Keypads, Seven Segment multiplexed Display, LCD, ADC Interfacing. All Programs in assembly language.

**Unit III: Interfacing-II** **6L**

Interfacing of DAC, Temperature sensors, Stepper motor, Motion detectors, Relay, Buzzer, Opto-isolators, Design of DAS and Frequency counter. All programs in assembly

**Unit IV: PIC Microcontroller Architecture** **6L**

PIC 10, PIC12, PIC16, PIC18 series comparison, features and selection as per application. PIC18FXX architecture, registers, memory Organization and types, stack, oscillator options, BOD, power down modes and configuration bit settings, timer and its programming. Brief summary of Peripheral support, Overview of instruction set, MPLAB IDE & C18 Compiler.

**Unit V: Real World Interfacing Part I** **6L**

Port structure with programming, Interrupt Structure (Legacy and priority mode) of PIC18F with SFRS. Interfacing of switch, LED, LCD (4&8 bits), and Key board. Use of timers with interrupts, CCP modes: Capture, Compare and PWM generation, DC Motor speed control with CCP: All programs in embedded C.

**Unit VI: Real World Interfacing Part II** **6L**

Basics of Serial Communication Protocol: Study of RS232, RS 485, I2C, SPI, MSSP structure (SPI &I2C), UART, Sensor interfacing using ADC, RTC (DS1306) with I2C and EEPROM with SPI. Design of PIC test Board, Home protection System: All programs in embedded C.

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**Text Books**

1. Mazidi, 8051 microcontroller & embedded system 3rd Edition ,Pearson
2. Mazidi, PIC microcontroller & embedded system 3rd Edition ,Pearson

**Reference Books**

1. 18F xxx reference manual www.microchip.com
2. I2C, EEPROM, RTC data sheets from www.ti.com

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**Data Communication (304205)**
**Credits: TH-03**

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester Assessment: 30 Marks
End Semester Examination: 70 Marks

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**Course Objectives:**

- To provide an in-depth introduction to all aspects of data communication system.
- To define different data formats for better data transmission.
- To introduce various digital baseband and bandpass modulation schemes.
- To identify the need of data coding and error detection/correction mechanism.
- To provide knowledge of various multiplexing schemes.

**Course Outcomes:**

After successfully completing the course, students will be able to

- Define and explain terminology of data communications
- Understand the impact and limitations of various modulation techniques.
- Get exposure to entropy and other coding techniques.
- Identify and explain error detection and correction using appropriate techniques.
- Design of data communication system.
- To acknowledge the need of spread spectrum schemes.

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**Unit I: Data Transmission Fundamentals 8L**

Data transmission concepts and terminology, analog and digital data transmission, Transmission modes (simplex, half duplex, full duplex), Transmission Impairments and Channel Capacity, transmission media : Guided ( UTP, STP, Optical, coaxial) & wireless(Radio wave, Microwave, Infrared ), Data Transmission( parallel and serial-synchronous and asynchronous transmission), analog and digital signal properties, Bandwidth, bit rate, baud rate data rate limits, Connecting devices: Hubs/Repeaters, Switches, Bridges, Routers, Layered Architecture (OSI Model), ISDN

**Unit II: Error Control Coding 8L**

Linear block codes, Hamming code, Hamming distance, CRC, syndrome detection, convolution code, trellis diagram, coding gain, Veterbi algorithm for detection

**Error control systems**: FEC, ARQ Stop and Wait, Hybrid ARQ, go back N, selective repeat.

**Unit III: Information Theory 6L**

The concept of Information, Information rate, entropy, mutual information, channel capacity, Bandwidth-SNR tradeoffs, use of orthogonal signals to achieve Shannon's limit.

**Entropy coding**: overview of BSC, Huffman coding, Shannon-Fano coding, code efficiency, channel through put.

**Unit IV: Baseband Signal Encoding 8L**

Block Diagram of Digital Communication System, Digital Versus Analog Sampling Process, PCM Generation and Reconstruction, Quantization Noise, Non-uniform Quantization and Companding, DM, ADM, DPCM and applications,

**Basic line codes**: RZ, NRZ, Unipolar, Polar, Bipolar, AMI, Manchester: properties and comparison; Multilevel line codes: MLT3, 2B1Q.

**Unit V: Bandpass Digital Signalling 8L**

Generation, detection, signal space diagram ASK, FSK, PSK, QPSK, OQPSK, QAM schemes, comparison.

**M-ary signalling**: MPSK, MFSK signalling, OFDM.

**Unit VI: Multiple Access Techniques 6L**

Introduction to Multiple Access Techniques – TDMA, FDMA, CDMA Spread spectrum techniques DSSS and FHSS, introduction to orthogonal codes and their properties; suitable example of orthogonal code and its autocorrelation, random access, Pure and slotted ALOHA, Media access control protocol (CSMA)

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**Text Books**

1. Bernard Sklar, Digital Communication,2/E, Pearson Education India, 2009
2. Willam Stallings, Data and Computer Communications,8/E, Pearson, 2007

**Reference Books**

1. Behrouz A. Forouzan, Data Communications and Networking, 4/E, McGraw-Hill, 2006
2. Leon W. Couch II, Digital and Analog Communication Systems, 6/E, Pearson Education Asia, 2002
3. Taub Schilling, Principals of Communication Systems, 2/E, Tata McGraw Hill, 2004
4. John J Proakis, Digital Communications, 3/E, McGraw-Hill Higher Education, 2001
5. Simon Haykin, Digital Communication, 4/E, Wiley,1988

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**Instrumentation and Power Electronics Lab (304211)**
**Credits: PR-02**

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| Practical: 4hrs/week | Practical: 50 Marks |
| | Term work: 50 Marks |

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## Instrumentation Systems

**List of Experiments: (Any 8 experiments)**

1. Weight measurement using load cell and strain gauges.
2. Measurement of vibration.
3. Liquid level measurement(Capacitance probe/ Ultrasonic/Hydrostatic-any one technique)
4. Measurement of speed of rotation of shaft using optical incremental encoder.
5. Temperature measurement. (RTD signal conditioning with bridge circuit, instrumentation amplifier, ADC and microcontroller)
6. Simulation of temperature measurement experiment with any software's (RTD signal conditioning with bridge circuit, instrumentation amplifier, ADC and microcontroller).
7. Design of signal converters using Electronics/electro-mechanical components (any one out of V/I, I/V, I/P, P/I)
8. Pneumatic cylinder sequencing with simple logic.
9. Data acquisition and analysis using PC.
10. Study of various switches
11. Study of different valves and their characteristics.
12. Study of characteristics of valves

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## Power Electronics & Applications:

**List of Experiments:**

1. V-I Characteristics of MOSFET / IGBT
2. V-I Characteristics of SCR & measurement of holding & latching current
3. Triggering circuit for MOSFET / IGBT.
4. Triggering circuit for thyristor (Using UJT or specialised IC)
5. Single phase Semi / Full Converter with R & R-L load
6. Three phase Semi / Full Converter with R load
7. Single-Phase PWM bridge inverter for R load

**OR**

8. Three-Phase inverter for R load
9. Four quadrant chopper operation

**OR**

10. Load and Line Regulation of SMPS
11. Simulation of Three phase Semi/Full converter for R and RL load.

**OR**

12. Simulation of Three phase PWM inverters for R and RL load.

13. Study of DC-DC Buck converter
    a. Analyze the influence of voltage loop feedback compensation on load-transient response of current-mode control TPS54160 buck regulator.
    b. Analyze the way the operating conditions influence the current ripple and voltage ripple of a TPS54160 buck regulator, depending on the type of core material of the inductor and on core saturation

**OR**

**14.** With TPS7A4901 study-
    a. Impact of line and load conditions on drop out voltage
    b. Impact of line and load conditions on efficiency
    c. Impact of capacitor on PSRR
    d. Impact of output capacitor on load-transient response

**15.** Case study of any one of the following: HVDC transmission system, Photovoltaic System, Wind generator system

**Microcontroller and Data Communication Lab (304212)**
**Credits: PR-02**

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| Practical: 4hrs/week | Practical: 50 Marks |
| | Term work: 50 Marks |

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## Microcontrollers and Applications

**List of Experiments:**

**Experiments 1 and 2 are compulsory. Perform any 8 experiments from 3 to 12.**

1) Interfacing LED bank to 8051 microcontroller using timer with interrupt.
2) Interfacing Seven Segment Display to 8051 microcontroller
3) Write a program for interfacing button, LED, relay & buzzer to PIC18FXX as follows:
   a) when button 1 is pressed, relay and buzzer is turned ON and LED's start chasing from left to right
   b) when button 2 is pressed, relay and buzzer is turned OFF and LED start chasing from right to left
4) Display message on LCD without using any standard library function for PIC18Fxx.
5) Interfacing 4X4 keypad and displaying key pressed on LCD OR on HyperTerminal for PIC18Fxx.
6) Generate square wave using timer with interrupt for PIC18Fxx.
7) Serially transfer the data on PC using serial port of PIC18Fxx.
8) Generation of PWM signal from PIC18Fxx for DC Motor control.
9) Interface analog voltage 0-5V to internal ADC and display value on LCD.
10) Using DAC generate various waveforms.
11) Interfacing DS1307 RTC chip using I2C and display date and time on LCD.
12) Interfacing EEPROM 24C128 using SPI to store and retrieve data.

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## Data Communication

**List of Experiments: (Any seven from 1 to 9):**

1. Experimental Study of PCM and Companded PCM.
2. Experimental study of Differential Pulse Code Modulation or delta modulation and signal reconstruction
3. Experimental study of basic line codes and Multi level line codes
4. Experimental study of ASK modulation and demodulation
5. Experimental study of PSK modulation and demodulation
6. Experimental study of FSK modulation and demodulation
7. Experimental study of QPSK and OQPSK modulation and demodulation
8. Design of PN sequence generator.
9. Experimental study of generation and detection of Spread Spectrum System (DSSS)

**Software Assignments: (Any two from 10 to 12):**

10. Implementation of linear block code
11. Implementation of Convolution code and Viterbi algorithm
12. Implementation of Shannon Fano and Huffman codes

**Electronics System Design Practice (304213)**
**Credits: TH- 02+OR-01**

**Teaching Scheme:**
Lectures: 2Hrs/ Week
Practical: 2Hrs/Week

**Examination Scheme:**
Oral: 50 Marks

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## Course Objectives:

- To teach the student, the art of applying basic concepts for designing electronic systems
- To imbibe good design practices for robust design of electronic systems
- To highlight the importance and significance of customer specifications/requirements
- To teach electronic circuit function verification with an EDA tool
- To create an interest in the field of electronic design as a prospective career option

## Course Outcomes:

After successfully completing the course students will be able to

- Shall be able to understand and interpret the specifications
- Shall be able to select optimal design topologies
- Shall be able to interpret datasheets and thus select appropriate components and devices
- Shall be able to use an EDA tool for circuit schematic and simulation
- Shall be able to design an electronic system/sub-system and validate its performance by simulating the same

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**Unit I: Design of Linear Power Supply & SMPS** **6L**

Typical specifications, Concept of ideal power supply & Voltage regulation, Rectifier and filter design, Heat-sink selection, Three terminal IC regulator & Variable Regulator.

**SMPS**: Advantages of SMPS, Basic concept of switching regulator, Basic topologies, Step down converter, Step up converter, Polarity inverter, Filter capacitor and inductor.

**Unit II: Design of Data Acquisition Systems (DAS)** **6L**

Need of DAQ, Block diagram of DAQ, Application Areas of DAQ, Performance parameters of DAQ, Selection of Sensor, Transducers, and Actuator, Interfacing of sensor, Need of signal conditioners, Design of signal conditioning circuits, Selection criteria for ADC and DAC, Selection Criteria of Microcontrollers, RS-232 PC Interfacing using serial communication, Overview of storage interface (like SD-Card, Serial EEPROM), LCD Display interfaces

**Unit III: Design of Electronics System 5L**

Design of Solar Power System: Load Power Calculations & Component Selection & design, Solar Panel Selection, Battery Types & Selection Criteria, Charge Control unit Design, Buck/Boost Convertor Design.

**Unit IV: Design using Internet of Things 6L**

IoT overview and architecture, Overview of wireless sensor networks and design examples. Various wireless connectivity: NFC, ZigBee, Bluetooth , Bluetooth Low Energy , Adding Wi-Fi capability to the Microcontroller , Wi-Fi MCUs (e.g., CC3200).

**Unit V : PCB Design 4L**

Types of PCB, PCB artwork components (pads, vias, tracks, footprints) and their metrics, Netlists, Power planes, High frequency considerations, Power considerations, Design Artwork (double sided PTH), Carry out signal integrity analysis.

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**List of Assignments:**

**Note:**

• Students are expected to complete FOUR assignments during the semester.

• Paper design should be functionally verified with an appropriate EDA tool (NI Multisim / Orcad / Pspice / open source)

• Specifications should be different for different group of students

• Documentation shall consist of:

- Problem statement
- Specifications
- Block Diagram
- Detailed circuit diagram (separate sheet Imperial /Half Imperial size)
- Calculations
- Component selection
- Calculations using the selected component values
- Simulation results (partial simulations , in the case where models are not available)
- Component List
- Conclusion
- Datasheets]

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**Assignment 1**:

A) Design of Linear Power Supply:

– Single Polarity (Fixed, Display)

- Dual Polarity (Fixed, Display)
- Variable Polarity (display)

B) Design of Switched Mode Power Supply

– Single polarity, multiple outputs (Buck/Boost/Flyback)

**Note:**

- Heat-sink design is mandatory wherever necessary
- Transformer design steps are expected

**Assignment 2**: Design of Data Acquisition System

- Multi-channel data acquisition systems
- Serial communication
- RTC interface, LCD display,
- DC motor driver, relay driver

**Note:**

• Sub-circuit designs are also expected except for power supply sub-system

• Micro-controller programming is expected (cross-compiler/assembly language)

**Assignment 3**: Design IoT applications using Raspberry Pi / equivalent.

**Assignment 4**: Design of Solar Power System for any particular application: e.g. Home applications, Water pumping applications.

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**Reference Books**

1. Practical design of power supplies" , Ron Lenk, John Wiley & Sons, 2005, ISBN: 978-0-08-097138-4
2. "Intuitive Analog Circuit Design A Problem-Solving Approach using Design Case Studies", Marc T. Thompson, Elsevier Inc, 2006,ISBN-10: 0-7506-7786-4
3. "Linear Circuit Design Handbook", Hank Zumbahlen, Elsevier Inc, 2008 , ISBN 978-0-7506-8703-4
4. "The Circuit Designer's Companion", Peter Wilson, Elsevier Ltd, 2012
5. "Switching Power Supply Design," 3E, Abraham I. Pressman et. al, McGraw-Hill, 2009
6. "Measurement, Instrumentation, and Sensors Handbook", John G. Webster, CRC Press, 1999
7. "Electronic Filter Design Handbook", 4E, Arthur Williams, Fred Taylor, McGraw-Hill, 2006

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**Semester II**

**DSP and Applications (304206)**
**Credits: TH-03**

**Teaching Scheme:**
Lectures: 3 Hrs/ Week

**Examination Scheme:**
In Semester Assessment: 30 Marks
End Semester Examination: 70 Marks

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**Course Objectives:**

- To understand the digital signal processing, sampling and aliasing.
- To introduce students with transforms for analysis of discrete time signals and systems.
- To use and understand implementation of digital filters.
- To understand concept of sampling rate conversion and DSP processor architecture

**Course Outcomes:**

After successfully completing the course students will be able to,

- The student will be capable of calibrating and resolving different frequencies existing in any signal.
- The student will be in position to understand use of different transforms and analyze the discrete time signals and systems.
- The student will realize the use of LTI filters for filtering different real world signals.
- The student will be in a position to design and implement multistage sampling rate converter.

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**Unit I: DSP Preliminaries** **6L**

Sampling, DT signals, sampling theorem in time domain, sampling of analog signals, recovery of analog signals, and analytical treatment with examples, Concept of Multirate DSP, Sampling rate conversion by a non-integer factor, Design of two stage sampling rate converter, mapping between analog frequencies to digital frequency, Basic elements of DSP and its requirements, advantages of Digital over Analog signal processing.

**Unit II: Discrete Fourier Transform** **8L**

DTFT, Definition, Frequency domain sampling, DFT, Properties of DFT, circular convolution, linear convolution, Computation of linear convolution using circular

convolution, FFT, decimation in time and decimation in frequency using Radix-2 FFT algorithm, Linear filtering using overlap add and overlap save method.

**Unit III: Z transforms 6L**

Need for transform, relation between Laplace transform and Z transform, between Fourier transform and Z transform, Properties of ROC and properties of Z transform, Relation between pole locations and time domain behavior, causality and stability considerations for LTI systems, Inverse Z transform, Power series method, partial fraction expansion method, Solution of difference equations.

**Unit IV: IIR filter design 8L**

Concept of analog filter design (required for digital filter design), Design of IIR filters from analog filters, IIR filter design by approximation of derivatives, , IIR filter design by impulse invariance method, Bilinear transformation method, warping effect. Characteristics of Butterworth filters, Chebyshev filters and elliptic filters, Butterworth filter design, IIR filter realization using direct form, cascade form and parallel form, Finite word length effect in IIR filter design.

**Unit V: FIR filter design 6L**

Ideal filter requirements, Gibbs phenomenon, windowing techniques, characteristics and comparison of different window functions, Design of linear phase FIR filter using windows and frequency sampling method. FIR filters realization using direct form, cascade form and lattice form, Finite word length effect in FIR filter design.

**Unit VI: DSP Applications 6L**

General Architecture of DSP, Issues involved in DSP processor design– speed, cost, accuracy, pipelining, parallelism, quantization error, etc Overview of DSP in real world applications such as Digital crossover audio systems, Interference cancellation in ECG, Compact disc recording system, Vibration signature analysis for defective gear teeth, Implementation of Triggering for Converter, D.C.Motor Control, AC Phase Control, Proportional Control.

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**Text Books**

1. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing: Principles, Algorithms and applications” Fourth edition, Pearson Prentice Hall.
2. S. Salivahanan, C. Gnanpriya, “Digital Signal processing”, McGraw Hill

**Reference Books:**

1. Ifaeachor E.C, Jervis B. W., “ Digital Signal processing : Practical approach”, Pearson publication
2. Dr. Shaila Apte, “Digital Signal Processing” Wiley India Publication, second edition

3. K.A. Navas, R. Jayadevan, “Lab Primer through MATLAB”, PHI
4. Li Tan, Jean Jiang, “Digital Signal Processing: Fundamentals and applications“ Academic press

## Embedded Processors (304207)

**Credits: TH-04**

**Teaching Scheme:**
Lectures: 4 Hrs/ Week

**Examination Scheme:**
In Semester Assessment: 30 Marks
End Semester Examination: 70 Marks

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**Course Objectives:**

- To understand need and application of ARM Microprocessors in embedded system.
- To study the architecture of ARM series microprocessor
- To understand architecture and features of typical ARM7& ARM CORTEX-M3 Microcontroller.
- To learn interfacing of real world input and output devices
- To learn MSP430 Microcontroller and low power features.

**Course Outcomes:**

After successfully completing the course students will be able to

- Describe the ARM microprocessor architectures and its feature.
- Interface the advanced peripherals to ARM based microcontroller
- Design embedded system with available resources.
- Design simple applications using MSP430

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**Unit I: MSP430 Microcontroller Architecture and Low Power Features 8L**

Low Power 16-bit MSP430x5xx microcontroller architecture, address space, on-chip peripherals (analog and digital), and Register sets. Instruction set, instruction formats, and various addressing modes of MSP430 devices; Variants of the MSP430 family viz. MSP430x2x, MSP430x4x, MSP430x5x and their targeted applications, System clocks. Low Power aspects of MSP430: low power modes, Active vs Standby current consumption, FRAM vs Flash for low power; reliability.

**Unit II: Real World Interfacing 6L**

GPIO programming and I/O multiplexing; Interrupts and interrupt programming. Watchdog timer. Timers & Real Time Clock (RTC), PWM control. Analog interfacing and data acquisition: ADC and Comparator in MSP430, data transfer using DMA. Serial communication basics, Synchronous/Asynchronous interfaces (like UART, USB, SPI, and

I2C). UART protocol, I2C protocol, SPI protocol. Implementing and programming UART, I2C, SPI interface using MSP430, Interfacing external devices.

**Unit III: ARM7** **7L**

Introduction to ARM processors and its versions. ARM7, ARM9 & ARM11 comparison, advantages & suitability in embedded application. ARM7 data flow model, programmer's model, modes of operations, Instruction set.

**Unit IV: ARM7 Based Microcontroller** **7L**

ARM7 Based Microcontroller LPC2148: Features, Architecture (Block Diagram and Its Description), System Control Block ( PLL and VPB divider) , Memory Map, GPIO, Pin Connect Block, timer, interfacing with LED, LCD, KEYPAD.

**Unit V: Real World Interfacing with ARM7 Based Microcontroller** **7L**

Interfacing the peripherals to LPC2148: GSM and GPS using UART, on-chip ADC using interrupt (VIC), EEPROM using I2C, SD card interface using SPI, on-chip DAC for waveform generation.

**Unit VI: ARM CORTEX Processors** **7L**

Introduction to ARM CORTEX series, improvement over classical series and advantages for embedded system design. CORTEX A, CORTEX M, CORTEX R processors series, versions, features and applications. Need of operating system in developing complex applications in embedded system, desired features of operating system & hardware support from processor, Firmware development using CMSIS standard for ARM Cortex. Survey of CORTEX M3 based controllers, its features and comparison.

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**Text Books:**

1. MSP430 microcontroller basics 1st Edition by John H. Davies (Author), Newnes Publication ISBN- 13: 978-0750682763
2. Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide – Designing and Optimizing System Software", ELSEVIER
3. Joseph Yiu, "The Definitive Guide to the ARM Cortex-M", Newness, ELSEVIER

**Reference Books:**

1. LPC 214x User manual (UM10139) :- www.nxp.com
2. LPC 17xx User manual (UM10360) :- www.nxp.com
3. ARM architecture reference manual : - www.arm.com
4. Trevor Martin, "An Engineer's Introduction to the LPC2100 series", Hitex (UK) Ltd.
5. Getting Started with the MSP430 Launchpad by Adrian Fernandez, Dung Dang, Newness publication ISBN-13: 978-0124115880

6. http://processors.wiki.ti.com/index.php/MSP430_LaunchPad_Low_Power_Mode
7. http://processors.wiki.ti.com/index.php/MSP430_16Bit_UltraLow_Power_MCU_Training

**Business Management and Organization (304208)**
**Credits: TH-03**

**Teaching Scheme:**
Lectures: 3 Hrs/ Week

**Examination Scheme:**
In Semester Assessment: 30 Marks
End Semester Examination: 70 Marks

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**Course Objectives:**

- To provide a basis of understanding to the students with reference to working of business organization through the process of management.
- Understanding of business concepts with a view to prepare them to face emerging challenge of managing business.

**Course Outcomes:**

After successfully completing the course students will be able to

- Understand Basic principles of management - will acquaint himself with management process, functions and principles
- Get the idea about new developments in management.
- Understand the basic concepts in commerce, trade and industry. He will be exposed to modern business world.
- Understand modern business practices, forms, procedures and functioning of various business organizations.

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**Unit I: Introduction 6L**

Meaning, scope and evolution of commerce & industry, -Industrial Revolution- its effects. Emergence of Indian MNCs & transnational corporations -Recent trends in business world. Globalization & challenges for Indian Business in new millennium

**Unit II: Business sectors & forms of business organizations 6L**

private sector, Cooperative sectors, public sector, joint sector, Services sector, Various forms of business organizations – Sole Proprietorship, Partnership firms, Joint stock companies – their features, relative merits, demerits & suitability.

**Unit III: Merges, acquisitions & Setting up new enterprises 6L**

Mergers in India. Networking, Franchising, BPOs & KPOs, E-commerce, On-line trading, patents, trademarks & copyright, Decisions in setting up an Enterprise – opportunity and idea generation, Role of creativity and innovation, Feasibility study and Business Plan, Business

size and location decisions, various factors to be considered for starting a new unit, Relevant Government Policies - SEZ (Special Economic Zone) policy etc.

**Unit IV: Business and Society 6L**

Changing Concepts and Objectives of Business, Professionalization, Business ethics, Business and culture, Technological Development and Social Change, Social Responsibility of Business, Social Audit.

**Unit V: Principles of Management 6L**

Nature of Management: Meaning, Definition, it's nature purpose, importance & Functions, Management as Art, Science & Profession- Management as social System Concepts of management-Administration-Organization, Evolution of Management Thought: Contribution of F.W.Taylor, Henri Fayol ,Elton Mayo, Functions of Management, Strategic Management.

**Unit VI: Strategic Management & Recent Trends in Management 6L**

Definition, Classes of Decisions, Levels of Decision, Strategy, Role of different Strategist, Relevance of Strategic Management and its Benefits, Social Responsibility of Management – environment friendly management Management of Change Management of Crisis Total Quality Management Stress Management International Management.

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**Text Books:**

1. Industrial Engineering & Management by O.P.Khanna
2. Modern Business Organization by S. A. Sherlekar
3. Industrial Organization Management: Sherlekar, Patil, Paranjpe, Chitale

**Reference Books:**

1. Business organization and Management by Talloo, Tata McGraw Hill
2. Business Environment and Policy – A book on Strategic Management/Corporate Planning by Francis Cherunilam Himalaya Publishing House 2001 Edition
3. Principles of Management, by Tripathi, Reddy, Tata McGraw Hill

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**Fundamentals of HDL (304209)**
**Credits: TH-03**

**Teaching Scheme:**
Lectures: 3 Hrs/ Week

**Examination Scheme:**
In Semester Assessment: Phase I : 30
End Semester Examination: Phase II: 70

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**Course Objectives:**

- To study basic programming in VHDL
- To learn Concepts of Verilog HDL

**Course Outcomes:**

After successfully completing the course students will be able to

1. Learn the role of HDL in digital system design using latest tools like VHDL and Verilog.
2. Describe and test digital logic circuits in data flow description, structural description, behavioral description and advanced constructs (procedures, tasks, functions) using both VHDL and Verilog.
3. Develop VHDL code to model and simulate basic combinational networks and sequential machines

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**Unit I: Introduction to HDL** **7L**

Introduction: Why HDL? A Brief History of HDL, Structure of HDL Module, Operators, Data types, Types of Descriptions, simulation and synthesis, Brief comparison of VHDL and Verilog

**Unit II: Modelling styles in VHDL** **7L**

Data-Flow Descriptions: Highlights of Data-Flow Descriptions, Structure of Data-Flow Description, Data Type – Vectors. Behavioral Descriptions: Behavioral Description highlights, structure of HDL behavioral Description, The VHDL variable –Assignment Statement, sequential statements. Structural Descriptions: Highlights of structural Description, Organization of the structural Descriptions, state Machines

**Unit III: Programmable Logic Devices** **7L**

Complex Programmable Logic Devices – Architecture of CPLD, Organization of FPGAs, FPGA

Programming Technologies (SRAM, Antifuse), Programmable Logic Block Architectures, Programmable Interconnects, and Programmable I/O blocks in FPGAs

**Unit IV: Procedures and Functions** **7L**

Procedures and Functions: Procedures, Tasks, and Functions: Highlights of Procedures, tasks, and Functions, Procedures and tasks, Functions.

**Unit V: Introduction to Verilog HDL** **7L**

Program structure, Logic System, Nets, Variables, and Constants, Vectors and Operators, Arays, Logical Operators and Expressions.

**Unit VI: Design Elements in Verilog** **7L**

Compiler directives, structural design elements, Dataflow design elements, Behavioral design elements (Procedural Code)

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**Text Books:**

1. HDL Programming (VHDL and Verilog)- Nazeih M.Botros- Dreamtech Press (Available through John Wiley – India and Thomson Learning), 2006 Edition
2. John F Wakerly, Digital Design- Principles and Practices, Pearson education, 4th Edition

**Reference Books:**

1. VHDL –Douglas Perry, TMH
2. Stephen Brown & ZvonkoVranesic, Fundamentals of Digital Logic Design with VHDL,Tata McGrw-Hill, New Delhi, 2nd Ed., 2007
3. Verilog HDL –Samir Palnitkar, Pearson Education
4. Fundamentals of Digital Logic with Verilog Design-Stephen Brown, TMH

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**PLC & Applications (304210)**
**Credits: TH-03**

**Teaching Scheme:**
Lectures: 3 Hrs/ Week

**Examination Scheme:**
In Semester Assessment: 30 Marks
End Semester Examination:70 Marks

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**Course Objectives:**

- Ability to recognize industrial control problems suitable for PLC control.
- Overview of Ladder Logic Programming to Program PLC.
- The ability to select the essential elements and practices needed to develop and implement the Engineering Automation using PLC approach.

**Course Outcomes:**

After successfully completing the course students will be able to

- Understand concepts of PLC, its uses & applications.
- Develop PLC ladder programs for simple industrial applications.
- Use knowledge of Installation, troubleshooting & maintenance of PLC to provide solution for industrial automation problems.

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**Unit I : PLC Overview** **6L**

Definition & History of PLC, Basic structure & Components of PLC, Principle of Operation, Selection of PLC, Why Use PLC, PLC I/O Modules, Memory & How it is used, PLC advantages & Disadvantages, PLC vs Computers, , Overview of Micro PLCs.
Conventional ladders vs PLC Ladder logic, What is Logic? Overview of Logic functions, Number systems & Codes, Hardwired Logic vs Programmed logic, Programming word level logic instructions, Relation of digital gate logic to contact/coil logic, Relay logic, Relay Sequencers.

**Unit II : Basics of PLC Programming -I** **6L**

Processor memory organization, PLC Programming languages, Ladder diagrams, Relays, contactors, switches, sensors, output control devices, latching relays, ladder diagram elements. Instructions: Relay type instructions, Instruction addressing, Branch Instructions, Internal Relay Instructions, Programming. Write ladder logic for a) two switches labelled as A & B are wired in parallel controlling a lamp, where two switches are separate inputs. b) That will cause output, pilot light PL, to be on when selector switch SS is closed, push button PB is closed and limit switch LS is open.

**Unit III : Basics of PLC Programming -II 6L**

Basic Functions : PLC Timer & Counter functions, Timer & Counter Industrial applications, Arithmetic functions, Comparison functions, Jump functions, Data handling functions, Digital Bit functions, PLC matrix Functions, Advanced PLC Functions: Analog PLC operation, PID control of Continuous processes. Write a PLC program for a) controlling lubricating oil being dispensed from a tank, b) Automatic water sprinkler system of a garden.

**Unit IV : PLC Installation, Troubleshooting & Maintenance 6L**

Installation : Consideration of operating environment, Receiving test, check & assembly, Electrical Noise, Leaky inputs & outputs, Grounding, voltage variations & surges, Circuit protections & wiring, Program Editing & Commissioning. Troubleshooting: Processor module, Input & Output malfunctions, Ladder logic program. PLC Maintenance.

**Unit V : Process control, HMI & SCADA 6L**

Types of processes, structure of control systems, on/off control, PID Control, Motion control, SCADA (Supervisory control and data acquisition): Block diagram, RTU (Remote terminal unit), Functions of RTU, MTU (Main terminal unit), functions of MTU, operating interfaces & applications, HMI (Human Machine Interface, Interfacing technique of PLC with HMI.

**Unit VI : PLC Networking & Applications 6L**

Types of communication interface, Types of networking channels, Advantages of standard industrial network, Serial communication, Industrial network : CAN ( Controller area network), Devicenet, Controlnet, Ethernet/IP, Modbus, Fieldbus, Profibus-PA/DP, SCADA (Supervisory control & data acquisition), HMI (Human Machine Interface), Two-axis, three axis robot control with PLC, Examples of some simple automated systems.

**Text Books**

1. “Programmable Logic Controllers” Frank D. Petruzella, Fourth Edition, McGraw-Hill Education,
2. “Programmable logic controllers & Industrial Automation” Madhuchandra Mitra, Samarjeet Sen Gupta, Fourth reprint 2012. Penram International Pvt.Ltd.

**Reference Books**

1. "Programmable Logic Controllers, Principles & Applications" John W. Wobb, Ronald A. Rais, Fifth Edition, PHI publishing.
2. "Introduction to Programmable Logic Controllers "Garry Dunning, 3rd Edition, Thomson, Delmar Learning.
3. Curtis Johnson, "Process Control Instrumentation Technology"; 8th Edition, Pearson Education.

**Embedded and DSP Lab (304214)**
**Credits: PR-02**

**Teaching Scheme:**
Practical: 4 Hrs/ Week

**Examination Scheme:**
Practical: 50 Marks
Term work: 50 Marks

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**Embedded Processors**

**List of Experiments:**

**(5 from each group)**

**Group A: Experiments using MSP430:**

1. Learn and understand how to configure MSP-EXP430G2 digital I/O pins. Write a C program for configuration of GPIO ports for MSP430 (blinking LEDs, push buttons interface). **Exercises:**
    a. Modify the code to make the green and red LEDs blink.
    b. Modify the delay with which the LED blinks.
    c. Modify the code to make the green LED blink.
    d. Alter the code to turn the LED ON when the button is pressed and OFF when it is released.
    e. Alter the code to make the green LED stay ON for around 1 second every time the button is pressed.
    f. Alter the code to turn the red LED ON when the button is pressed and the green LED ON when the button is released.

2. **Usage of Low Power Modes:**

    Configure the MSP-EXP430G2 for Low Power Mode (LPM3) and measure current consumption both in active and low power modes. Use MSPEXP430FR5969 as hardware platform and measure active mode and standby mode current.

    **Exercises:**

    a) How many Low power modes are supported by the MSP430G2553 platform?
    b) Measure the Active and Standby Current consumption in LPM3 mode for the same application using MSP430F5529

3. **Learn and understand GPIO based Interrupt programming**. Write a C program and associated GPIO ISR using interrupt programming technique.

   **Exercises:**

   a) Write the code to enable a Timer interrupt for the pin P1.1.
   b) Write the code to turn on interrupts globally.

4. **Implement Pulse Width Modulation** to control the brightness of the on-board, green LED. This experiment will help you to learn and understand the configuration of PWM and Timer peripherals of the MSP430G2553.

   **Exercises:**

   a) Observe the PWM waveform on a particular pin using CRO.
   b) What is the maximum resolution of PWM circuitry in MSP430G2553?
   c) Change the above code to create a PWM signal of 75% duty cycle on particular PWM pin.

5. The main objective of this experiment is to control the on-board, red LED by the analog input from a potentiometer. This experiment will help you to learn and understand how to configure an ADC to interface with a potentiometer.

   **Exercises:**

   a) Alter the threshold to 75% of Vcc for the LED to turn on.
   b) Modify the code to change the Reference Voltage from Vcc to 2.5V.

6. Learn and understand how to **configure the PWM and ADC modules** of the MSP-EXP430G2 to control the DC motor using external analog input.

   **Exercises:**

   a) What is the maximum resolution of PWM circuitry in MSP430G2553 and how it can be achieved using program?
   b) Create a PWM signal of 75% duty cycle on particular PWM pin.
   c) Create Switch case code from the example code to run the DC Motor in 3 set of speeds.

7. Configure of Universal Serial Communication Interface (USCI) module of MSP430G2553 for UART based serial communication. The main objective of this experiment is to use UART of the MSP430G2553 to communicate with the computer.

**Exercise:**

Modify the above code to transmit the set of strings to the serial terminal via UART as shown below:

char str1[]=”MSP430G2553 MCU”
char str2[]= “ Ultra low power mixed signal processing applications”

8. Understand and Configure 2 MSP430F5529 in **master-slave communication mode for SPI protocol.**

**Exercises:**
a) Which port pins of MSP430 can be configured for SPI communication?
b) What is the data transfer rate supported by MSP430 for SPI communication?

**Group B: LPC2148 Based Experiments**

9. Interfacing LPC2148 to LCD
10. UART Interfacing LPC2148 in embedded system (GSM/GPS)
11. Interfacing LPC2148 for internal ADC on interrupt basis
12. Interfacing SD card to LPC2148
13. Interfacing EEPROM to LPC2148 using I2C protocol
14. Interfacing LPC2148 to Seven Segment / RGB LED
15. Generation of PWM signal for motor control using LPC2148
16. Interfacing TFT display to LPC2148
17. Implementing CAN protocol using LPC2148

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## DSP and Applications

**List of Experiments:**

**Instructions:**

**Note: Experiments 1 to 10 can be performed in any appropriate software like C / MATLAB / Scilab etc. Minimum eight experiments to be performed. Experiment no. 11 is mandatory**.

1. Implement the sampling theorem and aliasing effects by sampling an analog signal with various sampling frequencies.
2. Design and implement two stage sampling rate converter.
3. To study the properties of DFT. Write programs to confirm all DFT properties.

4. To study the circular convolution for calculation of linear convolution and aliasing effect. Take two sequences of length
5. Write a program to find 4 point circular convolution and compare the result with 8 point circular convolution to study aliasing in time domain.
6. a) To find Z and inverse Z transform and pole zero plot of Z-transfer function.
   b) To solve the difference equation and find the system response using Z transform.
7. To plot the poles and zeros of a transfer function when the coefficients of the transfer function are given, study stability of different transfer functions.
8. To study the effect of different windows on FIR filter response. Pass the filter coefficients designed in experiment 6 via different windows and see the effect on the filter response.
9. Design Butterworth filter using Bilinear transformation method for LPF and write a program to draw the frequency response of the filter.
10. To plot the mapping function used in bilinear transformation method of IIR filter design.(assignment may be given)
11. Effect of coefficient quantization on the impulse response of the filter using direct form I and II realization and cascade realization.(theory assignment)
12. To implement at least one of the following operations using DSP Processor
    i. Linear and Circular convolution.
    ii. Low pass filter an audio signal input to DSK with FIR filter.
    iii. Low pass filter an audio signal input to DSK with IIR filter.
    iv. To generate sine wave using lookup table with table values generated within the programme.

## PLC and HDL Programming Lab (304215)
## Credits: PR-02

**Teaching Scheme:**
Practical: 4 Hrs/ Week

**Examination Scheme:**
Practical: 50 Marks
Term work: 50 Marks

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### PLC and Applications

**List of Experiments: (Any 8)**

Design & Simulate using any PLC simulation software.

1. Simple Start/Stop Ladder Logic Relay
2. Single Push Button On/Off Ladder Logic
3. PLC Program Example with On Delay Timer
4. PLC Program Example with Off Delay Timer
5. PLC Program Example with Retentive Timer
6. Star Delta PLC Ladder Diagram
7. Ladder Diagram for DOL Motor Starter
8. Traffic Light Ladder Logic Diagram
9. Ladder Diagram for Bottle Filling Plant
10. PLC Ladder Diagram for Elevator Control

11, 12, 13. Implement experiments 8, 9, and 10 using PLC hardware.

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### Fundamentals of HDL

**List of Experiments:**

1. Simulate Half adder and Full Adder using VHDL
2. Simulate 4:1 Mux using VHDL
3. Simulate all types of FlipFlops using VHDL
4. Simulate Shift Register(Left and Right shift) using VHDL
5. Simulate Half adder and Full Adder using Verilog
6. Simulate 3:8 Decoder using Verilog
7. Simulate Counter using Verilog
8. Simulate ALU using Verilog

## Mini Project (304216)

**Credits: TH- 02+OR-01**

**Teaching Scheme:**
Theory: 02 hr/week
Practical: 02 hr/week

**Examination Scheme:**
Oral : 50 Marks

**Course Objectives**

- To undertake & execute a Mini Project through a group of students, To understand the 'Product Development Cycle' through Mini Project.
- To plan for various activities of the project and distribute the work amongst team members.
- To learn budget planning for the project.
- To inculcate electronic hardware implementation skills by –
    a. Learning PCB artwork design using an appropriate EDA tool.
    b. Imbibing good soldering and effective trouble-shooting practices.
    c. Following correct grounding and shielding practices.
    d. Knowing the significance of aesthetics & ergonomics while designing electronic product.
- To develop student's abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project.
- To understand the importance of document design by compiling Technical Report on the Mini Project work carried out.

**Course Outcomes (COs)**
The student will be able to

- Planning and implementation of hardware/ software project
- Prepare the budget for hardware requirement
- Demonstrate the project
- Work as a team member.

**Maximum Group Size:** Minimum 2 and maximum 3 students can form a group for the mini project.

**Project Type:** The selected mini project must be based on development of a prototype electronic system/product mandatorily having a hardware component with supporting software.

The Assessment Scheme will be:

a. **Continuous Assessment 50 marks** *(based on regular interaction, circuit development)*
b. **End Semester 50 marks** *(based on implementation, testing, results, poster presentation, and demonstration)*

**Execution steps for Mini Projects:**

1. Complete Paper work Design using datasheets specifying:
   · Selection criteria of the components to be used.
   · Specifications of system i/p and desired o/p.
   · Module based hardware design.
   · Test points at various stages in various modules
2. The circuit should be simulated using any of the standard simulation software available (either complete circuit to be simulated, if possible or an appropriate part of the circuit can be simulated)
3. Algorithm and the flow chart of the software part must be defined.
4. Result verification for hardware and testing the algorithms.
5. Comparison with the paper design to identify the discrepancies, if any. Justification of the same must be given.
6. Verified circuit should be assembled and tested on breadboard or general purpose board.
7. Simulation results and/or the snapshots indicating the current and voltage readings or detailing the test point results at various stages must be preserved and included in the project report.
8. Art work / layout of the circuit using standard layout tools.
9. Assembling and testing of circuit on final PCB.
10. Design and fabrication of suitable enclosure and outside fittings such as switches, Buttons, knobs, meters, indicators, displays etc.
11. Final testing of the circuit using the earlier defined test points.
12. Preparing Bill of components and materials.
13. Drawing entire circuit diagram (component level), outlining various blocks indicating test points, inputs and outputs at various stages on A3 graph sheet.

**Domains for projects may be from the following, but not limited to:**

- Instrumentation and Control Systems
- Electronic Communication Systems
- Biomedical Electronics
- Power Electronics
- Audio , Video Systems
- Embedded Systems
- Mechatronic Systems

**A project report with following contents shall be prepared:**

- Title
- Specifications
- Block diagram
- Circuit diagram
- Selection of components
- Simulation results
- PCB artwork
- Layout versus schematic verification report
- Testing procedures
- Enclosure design
- Test results
- Conclusion

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**References**

**Text Books:**

1. Thomas C Hayes, Paul Horowitz, "The Art of Electronics", Newens Publication
2. Analog Circuit Design: Art, Science and Personalities, by Jim Williams (Editor) , EDN series for Design Engineers,
3. M Ashraf Rizvi, " Effective Technical Communication", Tata McGraw Hill Pvt. Ltd.

**Reference Books:**

1. Robert Boylested, " Essentials of Circuit Analysis", PHI Puublications
2. Meenakshi Raman, Sangeeta Sharma," Technical Communication, Principles and Practice", Oxford University Press
3. A.E. Ward, Angus, " Electronic Product Design", Stanley thornes Publishers, UK.

C Muralikrishna, Sunita Mishra," Communication Skills for Engineers", Pearson

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