Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Autonomous)

Academic Year 2023-2024

Course Structure for M.Sc. - II: Electronic Science

Semester	Paper Code	Title of Paper	No. of Credits
III	PSEL231	Advanced Communication Electronics	4
	PSEL232	Advanced Embedded Systems	4
	PSEL233	Digital Signal Processing	4
	PSEL234	Programmable Logic Controllers and Supervisory Control & Data Acquisition	4
	PSEL235	Practical Course –V	4
	PSEL236	Practical Course –VI	4

PSEL231: Advanced Communication Techniques (4 Credits)

Objectives:

1. To learn analog modulation techniques
2. To learn various digital modulation techniques.
3. To study basic digital communication system and digital codes.
4. To learn error detection and correction codes.
5. To understand the basics and technology of advanced communication system.

Course Outcome:

1. Student will be able to learn advanced communication technology.
2. Student will be able to learn digital modulation techniques.
3. Student will be able to learn Analog modulation techniques.

Unit 1: Analog Communication [15]

Analog communication systems, Modulation, Bandwidth requirements, External and Internal noise, Theory of Amplitude modulation, Power distribution, Generation of AM, Suppression of carrier, suppression of unwanted side Bands, Extensions of SSB. Theory of frequency and Phase modulation, sidebands and modulation index, Noise and Frequency modulation, Analog base band Transmission.

Unit 2: Digital Communication [15]

Digital Communication Pulse modulation, Pulse amplitude modulation, pulse width modulation, pulse position modulation, Delta modulation, Adaptive delta modulation, Digital modulation techniques- ASK, FSK, PSK, QAM, M-ary digital modulation techniques. Digital base band transmission. Coding Techniques- Introduction to the Coding, Alpha - Numeric coding, Parity Check Coding, Hamming Code, Concept of Systematic Code, RZ, NRZ, Manchester code, AMI, Error Detection and Error Correction.

Unit 3: Advanced Digital Communication Systems [15]

Satellite Communication, Satellite for Television applications: Direct-To-Home (DTH) and Cable TV. Voice and Data communication, Earth observation (Remote Sensing) applications, Military applications. Principle of digital telephony. 1G, 2G, 2.5G, 3G, 4G cellular networks, Cellular Phones concept, Frequency reuse, Capacity expansion techniques- Cell splitting and cell sectoring, working of a typical cellular system. Telephone, Dual Tone Multi Frequency (DTMF) dialing.

Unit 4: Communication Technologies [15]

Integrated Services Digital Network (ISDN), spread spectrum techniques, OFDM, 3G wireless, IP telephony, IrDA, CDMA Local Loop, PSTN, digital exchanges, Principles of Telemetry, VSAT, GSM,

Wireless communication: Bluetooth, Bluetooth-Components, Stack, Links and channels, Bluetooth networking, Applications. Features and applications of Wi-Fi, Hot-spot. ZIGBEE- Zigbee Applications.

Text / Reference Books

1. Electronic Communication Systems, George Kennedy and Bernard Davis Publ. Tata McGraw Hill.
2. Electronic communications, Dennis Roddy and John Coolen, Pearson Publ.
3. Communication Electronics Principles and applications, Louis E. Frenzel, Tata McGraw Hill.
4. Digital data communication, Miller Tomasi, Advanced Electronic Communication Systems, 6/e, Pearson, 2015.
5. W.C.Y.Lee, Mobile Cellular Telecommunication, McGraw Hill, 2010.

PSEL 232: Advanced Embedded Systems (Credit-4)

Objectives:

1. To study 32-bit Processor and Controller.
2. To learn ARM Cortex-M3.
3. To get familiar with real time operating system (RTOS)
4. To introduce Raspberry pi.

Course Outcomes:

1 .Design embedded applications with operating system support.
2. Design 32-bit system.
3. Design Raspberry pi python code.

Unit -1: ARM Cortex-M3 Processor Architecture [18]

Introduction: What Is the ARM Cortex-M3 Processor, Background of ARM and ARM Architecture,Cortex-M3 Processor Applications, Registers, Operation Modes, Memory Maps, The Pipeline, Bus Interfaces on the Cortex-M3, Other Interfaces on the Cortex-M3, Exceptions, Built-In Nested Vectored Interrupt Controller, Interrupt Behavior, Cortex-M3 Programming, Exception Programming, Advanced Programming Features and System Behavior, The Memory Protection Unit, Other Cortex-M3 Features, Debug Architecture, Debugging Components, Choosing a Cortex-M3 Product, Development Tools, Development Using the GNU Tool Chain.

Unit-2 : ARM Cortex-M3 Processor Implementation [15]

LPC176XIntroduction, Features, Applications, Device, information, Architectural overview, ARM Cortex-M3 processor, Block diagram, Memory maps, Clocking and Power control functions, Nested Vectored Interrupt Controller, Pin configuration, Pin connect block, GPIO, Ethernet, UART, CAN, SPI, I2C, Timer, Repetitive Interrupt Timer, System Tick Timer, PWM, Motor control PWM, ADC, DAC, RTC, WDT.
Programming: GPIO, UART, Timer, PWM, ADC, DAC, RTC.

Unit-3: Real Time Operating Systems (RTOS) [12]

Operating System basics, Types of Operating Systems, Tasks, Process, Threads, Multiprocessing and Multi tasking, Task Scheduling, Threads-Processes-Scheduling putting them together, Task Communication, Task Synchronization, Device Drivers, How to choose an RTOS.

Unit-4: Raspberry Pi with Python [15]

Basic functionality of the Raspberry Pi board and its processor, setting and configuring the board, differentiating Raspberry pi from other platform like arduino, asus thinker etc., overlocking Component overview. Communication facilities on Raspberry pi(I2C,SPI,UART)working with RPil. GPIO library, interfacing of Sensors and Actuators.

Text / Reference Books:

1. The Definitive Guide to the ARM CORTEX-M3 *2nd edition, by Joseph Yiu.*
2. Using the Free RTOS Real Time Kernel ARM Cortex-M3 Edition, *by Richard Barry*
3. UM10360 LPC176x/5x User manual.
4. Operating Systems Concept, Galvin, John Willey and Sons
5. Raspberry Pi for Python Programmers Cookbook - Second Edition 2nd Edition,Kindle Edition
6. Raspberry Pi® User Guide, 4Eben Upton Gareth Halfacree
7. Operating Systems Concept, Galvin, John Willey and Sons

PSEL233: Digital Signal Processing (Credits : 4)

Objectives:

1. To understand the sampling, aliasing and block schematic of digital signal processing.
2. To learn design of digital filters and implementation on digital Signal Processor
3. To understand DFT, FFT transforms for analysis of DT signals.
4. To make the students able to apply digital filters according to known filter specifications
5. To provide the knowledge about the principles behind the discrete Fourier transform (DFT) and its fast computation
6. To be able to apply the MATLAB Programme to digital processing problems and Presentations
7. To become familiar with digital image fundamentals.

Course Outcomes: On completion of the course, students will be able to –

1. Interpret and process discrete/ digital signals and represent DSP system.
2. Implement efficient transform/ algorithm and its application to analyze DT signals.
3. Design and implement IIR filters and FIR filters.
4. Apply knowledge of mathematics for image understanding and analysis.

Unit-1: Signals and Systems [12]

Overview: Classification of Signals and Systems, DSP system and interfacing A-D conversion process, sampling, quantization and encoding, oversampling and antialiasing, Nyquist rate & aliasing problem, anti aliasing,

Basic elements of DSP and its requirements, advantages of Digital over Analog signal processing, Introduction to DSP processor. types of DSP processors and architecture, general purpose DSP processors.

Unit-2: DFT and FFT [15]

Introduction to Fourier series, Fourier series Representation of periodic signals, Dirichlet Conditions, Evaluation of Fourier coefficients, Properties of Fourier Transform (FT), Discrete Fourier Transform (DFT) and its inverse DFT, Existence of DFT, properties of DFT, Circular convolution, linear convolution, Fast Fourier Transform (FFT), DIT, DIF algorithm. Inverse FFT.

Unit-3: Digital Filter Design [18]

Digital filters and analog filters. FIR filter: Windowing techniques: Gibbs phenomenon, characteristics and comparison of different window functions, Design of linear phase FIR filter using windows: Rect, Hanning, Hamming, Blackmann & Kaiser, Magnitude and Phase response of Digital filters, Frequency response of Linear phase FIR filters, FIR filter realization using Direct Form, Cascade and linear phase structure.

IIR Filter: IIR filter design by approximation of backward derivatives, IIR filter design by impulse invariance method, Bilinear transformation method, warping effect.IIR filter realization using direct form, cascade form and parallel form, Finite word length effect in IIR filter design.

Unit-4: Fundamentals of DIP [15]

Introduction, application fields of DIP, image sensing and acquisition, overview of image representation and modelling techniques. Elements of visual perception: luminance, brightness, contrast, hue, saturation and Mach band effect. Color image fundamentals: RGB and HIS models. DIP Techniques: Image Enhancement: point and spatial operation techniques. Image Segmentation: fundamentals, point, line and edge detection. Image Restoration. Boundary detection.

Text /Reference Books:

1. Digital Signal Processing: A Practical Approach, Emmanuel Ifeachor, Barrie Jervis, Prentice Hall.
2. S. Salivahanan, C. Gnanapriya , "Digital Signal Processing", McGraw Hill, 2nd Edition.
3. Digital Signal Processing: A Hands on Approach: Charles Schuller, Mahesh Chugani, Tata McGraw Hill Pub. Co. Ltd. Edn. 2006.
4. Digital Signal Processing: - Principles, Algorithms and Applications: John G Proakis, Dimitris G Monolkis, and Pub. Person 2005.
5. Digital Signal Processing and Applications with the C6713 and C6416 DSK, Rulph Chassaing, a John Wiley & Sons, Inc.
6. S Sridhar, "Digital Image Processing", Oxford University Press, 2nd Edition.
7. Jain Anil K., "Fundamentals Digital Image Processing", Prentice Hall India, 4th Edition.

PSEL234- Programmable Logic Controllers and Supervisory Control & Data Acquisition

Objectives:

1. To make the students aware of programmable logic controller hardware.
2. To introduce and study of ladder diagram and PLC programming.
3. To introduce PLC applications.
4. To introduce SCADA.

Course Outcomes:

1. Identify different components of PLC.
2. Develop PLC ladder programs for different applications.
3. Study of different cases using PLCs.
4. Test the simple SCADA application.

Unit 1: Introduction to PLC **[15]**

Need and benefits of Automation, Tools of Automation – PLC, PLC Architecture Block diagram, Working, CPU – Function, scanning cycle, Speed of execution, Memory Organization and function, sink and source concept in PLC, Input/output module with reference to sink or source, output module relay, transistor, triac, Signal conditioning, PLC Characteristics, PLC types – Fixed and Modular, PLC applications, PC v/s PLC.

Unit 2: PLC Programming **[15]**

Programming methods- Logic control elements (NOT, AND, OR, NAND, NOR etc.),ladder diagrams, function blocks, statement list, programming a PLC, programming terminals, ladder relay instructions, ladder relay programming (digital gates, Boolean expression, mux-demux, flip flop), **Timers, Counters and Registers -** Types of timers, programming timers, off-delay timers, pulse timers, programming examples, forms of counter, programming, up and down counting, timers with counters, sequencer, data handling: registers and bits, data handling, arithmetic functions, closed loop control shift registers, ladder programs, Concept of smart PLC,HMI using smart PLC.

Unit 3: Case studies of PLC **[15]**

Program development, Documentation programs- temperature control, valve sequencing, conveyor belt control, control of a process, traffic lights controller, bottle filling control, alarm monitor program, car parking, vending machine, automatic stacking program, AC motor drive interface, elevator, water level controller.

Unit 4: SCADA **[15]**

Introduction to SCADA, Applications of SCADA, SCADA Architecture (block diagram), Benefits of SCADA, Types of SCADA – Single Master Single Remote, Single Master Multiple Remote, Multiple Master Multiple Remote, SCADA System Hardware - Remote Terminal Units (RTUs), Master Terminal units (MTUs), Communication System. Difference between PLC and SCADA.

Text /Reference Books:

1. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers Principles and Applications", Fifth Edition, Prentice Hall Publication, New Delhi, 2002.
2. L.A. Bryan, E.A. Bryan, "Programmable controller theory and Implementations" second edition, An Industrial Text Company Publication.
3. W. Bolton, "Programmable Logic Controllers", Fifth Edition, Elsevier Publication
4. Dunning G., "Introduction to Programmable Logic Controllers", Thomson/ Delmar learning, 2005, ISBN – 13: 9781401884260.
5. Bailey David, Wright Edwin, "Supervisory Control and Data Acquisition", Newnes (an imprint of Elsevier), 2003. ISBN – 0750658053.

PSEL235: Practical course V

Objectives:

1. To learn analog modulation techniques
2. To learn various digital modulation techniques.
3. To learn different control system.
4. To learn various power Electronics Circuit.
5. To study different types of Motor.

Course Outcomes: On completion of the course, students will be able to

1. Design different analog and digital Modulation Techniques.
2. Design Various control system Application.
3. Design Various Power Electronic Circuit.
4. Designing different motor controlling Techniques.

Laboratory Practical: Any 10 Practicals from following sections

Advanced Communication Electronics

1. Design of AM/FM transmitter and receiver
2. Delta modulation
3. Design PCM encoder/ decoder system
4. Design of FSK transmitter and receiver
5. Time division Multiplexing
6. Telemetry Applications
7. Varactor diode characteristics and its application in FM
8. Design of FSK transmitter and receiver
9. Design of Binary Phase Shift Keying

Control Systems and Process Instrumentation

1. Signal conditioning circuits for analog controller
2. Design and implement ON-OFF Controller
3. Design and implement P / PI / PID controller
4. To study the position / velocity control of dc servo motor
5. Flow control using solenoid valve
6. Study of optical position encoder

Advanced Power Electronics

1. DC motor speed /AC motor speed control/ Stepper motor control
2. Practical based on Inverter.
3. Design single phase on-off controller.
4. Study of thyristor its characteristics.
5. Study of Commutation method of SCR.
6. Design Dual Power supply using Transformer.
7. Design Variable Power supply.

Mechatronics

1. Study of DC servo motor/BLDC motor.
2. Study of PMDC motor toque speed characteristics
3. Study of AC servo motor, its speed control/position control
4. Set up a flow control system using suitable flow sensor and actuator
5. study of actuators and their driving circuit (solenoids, motors etc.)
6. Study digital sensor

Activity: Industrial Visit / Hobby project (equivalent to practical experiments)

PSEL236: Practical course VI

Objectives:

1. To learn ARM Cortex-M3.
2. To introduce Raspberry pi.
3. To make the students aware of programmable logic controller hardware
4. Identify different components of PLC.
5. To be able to apply the MATLAB Programme to digital processing problems and Presentations

Course Outcomes: On completion of the course, students will be able to

1. Design embedded applications with operating system support
2. Design Raspberry pi python code.
3. Develop PLC ladder programs for different applications.
4. Design and implement IIR filters and FIR filters

Laboratory Practical: Any 10 Practicals from following sections

Advanced Embedded System

1. Interfacing Alphanumeric LCD to 32-bit microcontroller.
2. Interfacing matrix keyboard to 32-bit microcontroller.
3. Programming ADC of 32-bit microcontroller.
4. Programming DAC of 32-bit microcontroller.
5. Programming UART of 32-bit microcontroller.
6. Implementation of Multitasking using RTOS.
7. Implementation of Semaphore using RTOS.
8. LED, SSD, Stepper Motor, Switch interface to Raspberry Pi.
9. Camera Control using Raspberry Pi

Programmable Logic Controllers and Supervisory Control & Data Acquisition

1. Relay programming (all logic gates, boolean equation like multiplexer, demultiplexer, encoder, decoder, latch etc.)
2. Temperature controller
3. Conveyor belt control
4. Alarm monitor program
5. Vending machine
6. Water level controller

Digital Signal Processing

1. Generation of signals- Impulse, Step, Exponential and Ramp functions
2. Design of FIR filter, Design of IIR filter
3. Find DFT and IFT of given Example
4. Linear and circular convolution
5. To design low pass/ band pass filter using MATLAB.
6. To generate rectangular, hamming, hanning, blackman and kaiserwindow using MATLAB.
7. Implementation of Decimation Process / Interpolation Process

8. Implementation of image enhancement techniques in MATLAB.
9. Study and implementation of a segmentation techniques in MATLAB.
10. Study image restoration application using filtering techniques in MATLAB.
11. Implementation of boundary detection in MATLAB.

Communication:-

Experiments using MATLAB

1. Phase shift keying (PSK)
2. Generation and reception of BPSK
3. Generation and reception of FSK
4. Generation and reception of QPSK

Activity: Industrial Visit / Hobby project (equivalent to practical experiments)