EMBEDDED Systems

CURRICULUM

6 Months

» MODULE-1

» C programming with Data Structure

» Introduction to 'C'

- Objectives of C
- Applications of C
- Relational and logical operators
- Bit wise operators
- The assignment statement
- Intermixing of data types
- type conversion
- cast Operator
- Multiple assignment
- Type definitions
- Input/Output Routines
- Formatted and unformatted I/O operations

» Control Flow Statements In 'C'

- If statement
- else-if statement
- While statement
- for loop, do, while loop
- Switch
- break and continue
- goto

» Functions

- Definition of function and it's uses
- Format of a function
- Calling the function
- C storage classes - extern
- Automatic variables
- Static variables
- Register variables Recursive functions
- Command line arguments

» Array and String

- 1-D,2-D array and string
- String handling library functions
- Additional string functions
- Searching
- Sorting with dif ferent algorithms

» Pointers

- Introduction to pointers
- The 'address of' and 'indirection' operators
- Pointer expression
- Data types of pointers
- Pointers and arrays
- Assignment of pointers
- Pointer arithmetic
- Comparison of two pointers
- Pointers and functions
- Pointers and strings

» C Preprocessor

- Macros with Arguments
- Macro Versus Function
- Directive
- Conditional Directive

» Structures

- Introduction to structures
- Declaration and reference,
- Accessing structure elements,
- Array of structures,
- Nested structures,
- Self-referential structures,

» Union & Enumerated Data T ype

- Introduction to Union
- Dynamic memory allocation
- Typedef statement

» Files

- Introduction and need for a file
- Library functions to open/close a file,
- Functions to read/write a single
- Character from a file
- Formatted input output functions used in file
- handling fscanf(),
- fprintf(),
- fgets(), fputs()
- Flushing buf fers,
- Functions used in file handling - fseek(),

- ferror()
- ftell()
- feof(),
- fopen,fwrite,fread,
- File handling system calls - open(),
- read(), write(), lseek(), close(),
- Database handling in C

» MODULE-2 (Anyone among a/b/c/d)

» (a) 8051 (MicroControllers using Assembly and C)

» Introduction to Embedded System

- History & Need of Embedded System
- Basic components of Embedded System
- Hardware Classification of Embedded System
- Programming Language Classification of Embedded System
- Advantage & Disadvantage of Low level & High level programming language of Embedded System

» Microprocessor & Microcontroller Classification

- Difference between Microprocessor & Microcontroller
- Classification based on architecture
- Classification based on Instruction Set
- Type of Microcontroller
- Memory Classification

» Introduction to 8051 Microcontroller

- Introduction of ATMEL 8051 family
- Block diagram description of AT89C51
- Special feature of AT89C51
- Pin description of AT89C51

» Registers & Memory of AT89C51

- Description of RAM
- Description of CPU Registers
- Function of SFR

» Assembly Language Programming of AT89C51

- Addressing modes of AT89C51
- Directives of Assembly Language
- Data Transfer Instruction
- Jump Instruction
- Arithmetic Instruction
- Logical Instruction
- Branching Instruction

» Interfacing of LED AND MATRIX

- Introduction of LED's
- Interfacing Circuit Description of LED's
- Programming of LED's Interfacing
- Interfacing of LED Matrix

» Interfacing of Seven and Fourteen Segment Display

- Introduction to 7 Segment Display
- Types of 7 Segment Display
- Interfacing Circuit Description of 7 Segment Display
- Programming of 7 Segment Display Interfacing
- Introduction to 14 Segment Display
- Types of 14 Segment Display
- Interfacing Circuit Description of 14 Segment Display

» Interfacing of LCD

- Introduction to 16 x 2 LCD
- Commands of 16 x 2 LCD
- Interfacing Circuit Description of 16 x 2 LCD
- Programming of 16 x 2 LCD

» Interfacing of Switches & Keyboard Matrix

- Introduction to Switches & Keyboard Matrix
- Interfacing Circuit of Switches & Keyboard Matrix
- Programming of Keyboard Matrix & Switches
- Controlling of LED's by using Switches
- Key board Matrix & LCD Interfacing Program

» Interfacing of Motors

- Introduction to Motors
- Types of Motors used in Embedded System
- Programming & Controlling of Motors in Embedded System

» Timers & Counter Programming

- Introduction to Timer & Counter
- Difference between Timer and Counter
- Description of SFR associated with Timer & Counter
- Programming of Timer & Counter

» Serial Communication Programming

- Introduction to Serial Communication
- Types of Serial Communication
- Description of SFR associated with Serial Communication
- Introduction & Interfacing of UAR T
- Programming of UAR T

» Interrupt driven Programming

- Introduction to Interrupts
- Types of Interrupts
- Programming of Software & Hardware Interrupts

» Interfacing of ADC

- Introduction to ADC
- Interfacing circuit of ADC
- Working & Interfacing of Temperature Sensor (DS1621 & LM35)

» Interfacing of External Memory

- Introduction to External Memory Interfacing
- Introduction to I2C Protocol
- Using I2C library to read/write External Memory

» Introduction of EMBEDDED C

- Introduction to Embedded C
- Different between C & Embedded C
- Data Type of Embedded C
- Operators of Embedded C
- Statements & Loops of Embedded C

» Interworking of Assembly & Embedded C

- Inline Function
- Inline Assembly Routines

» Programming & Interfacing using EMBEDDED C

- Programming of Timer & Counter
- Programming of Serial Port
- Programming of Interrupt
- LCD Interfacing
- Motor Interfacing
- Key board Matrix Interfacing

» (b) Advanced Embedded System PIC (PIC18XXXX)

» Introduction to Embedded Systems

- History & need of Embedded System
- Basic components of Embedded System
- Hardware Classification of Embedded System
- Programming Language Classification of Embedded System

» Classification of Microprocessor & Microcontroller

- Difference between Microprocessor & Microcontroller
- Classification based on Architecture
- Classification based on Instruction Set
- Type of Microcontroller
- Memory Classification

» Brief Introduction to Computer Architecture

- Classification of V on-Neumann and Harvard Architecture
- Difference between RISC and CISC
- Memory Classification
  - Primary Memory
  - Secondary Memory

» Computer Languages

- Low Level Languages
- Middle Level Language
- High Level Language
- Advantage & Disadvantage of Low level & High level programming language of Embedded System
- Interaction of language with Compilers

» Embedded Development T ools

- Assembler
- Interpreter
- Compiler
- Simulator
- Emulator
- Debugger

» Designing with Microcontrollers

- Introduction to 8051 and Family
- Introduction to Microchip and Family
- Block Description of PIC 18F458
- PIN diagram Description of PIC 18F458
- Introduction of File Register (RAM)
- Introduction To RAM Architecture
- Access Bank
- Special Features of PIC18F458

» Introduction of EMBEDDED C

- Why C
- Benefits of C over Assembly
- Constants, V ariables & Data Types
  - Keywords & Identifiers
  - Data type & its memory representation
  - User Define data types (Structure)
  - Array
  - Pointers
- Operators
  - Arithmetical Operator
  - Logical Operator
  - Bitwise Operators
- Control Statement and Loops
  - If
  - Switch
  - For
  - While
  - Do While
- Introduction to preprocessor directives
- Assembly within C (Inline Assembly)

» Introduction to PIC18 Compiler/ Simulator

- MPLAB Compiler
- MPLAB C 18 Compiler
- Micro Pro C Compiler
- PIC18 Simulator IDE
- Proteus

» Real world interfacing – LED

- Brief introduction to P-N Junction Semiconductor Devices and LED
- Circuit Description of Interfacing LED
- LED Programming Patterns

» Real world interfacing – 7 segment display

- Theory of 7-Segment Displays
- Writing Decoding Chart for 0-f character
- Writing one digit UP/DOWN Counter Program
- Programming 2 Digit/3 Digit /4 Digit Counter
- Introduction To TLC (Traffic Light Controller) Programming

» Real world interfacing – LCD

- Block Diagram of LCD
- Types of LCD
- Pin Structure of 16x2 LCD
- Hardware Interfacing Circuit
- LCD Command set
- Writing program to drive LCD

» Timer/Counter programming

- Description of SFR associated with Timer/Counter
- Configuring as a Timer
- Configuring as Counter
- Delay Count Calculations

» Interfacing of switches & keyboard matrix

- Introduction to Switches & Keyboard Matrix
- Interfacing Circuit of Switches & Keyboard Matrix
- Programming of Keyboard Matrix & Switches
- Controlling of LED's by using Switches
- Key board Matrix & LCD Interfacing Program

» Real world interfacing – MOT ORS

- Different kind of Motors
- Interfacing of DC Motors and Stepper Motor
- Motor Drivers Interfacing
  - L293D
  - ULN2003

» Serial Communication programming

- Introduction to the Communication System
- Types of communication System
  - Analog / Digital
  - Serial / Parallel
  - Synchronous/ Asynchronous
- Introduction to Serial Communication
  - Simplex
  - Half Duplex
  - Full Duplex
- Description of SFR associated with Serial Communication
- Data Framing and UAR T Introduction
  - RS232 Protocol
- Introduction & Interfacing of UAR T
  - MAX 232 IC
- Programming of UAR T

» Interrupt driven programming

- SFR associated with Interrupts
- Interrupt Handling Methods
- Programming Hardware Interrupts
- Programming Timer Interrupts
- Programming Serial Interrupts

» Using and configuring adc

- Introduction to ADC
- ADC Initialization

» Introduction of sensors

- Introduction of Transducers
- Types of Sensors
- Sensor Interfacing
  - IR Sensor
  - Temperature Sensor

» Introduction to signal Decoder IC

- DTMF

» Protocol Interfacing

- SPI Protocol
  - Introduction to SPI Protocol
  - SPI Protocol Framing
  - Programming of SPI
- I2C Protocol
  - Introduction to I2C Protocol
  - I2C Protocol Framing
  - Programming of I2C

» Introduction to CCP and ECCP programming

- Standard CCP Module
- Enhanced CCP Module
- Compare mode programming
- Capture mode programming

» Using Internal/External Memories

- Introduction to External Memory Interfacing using Intel Bus Timing
- SFR configuration to read/write Internal Memory (EEPROM)
- Using library to read/write Internal EEPROM

» (c) Embedded Systems with Microcontroller (AVR)

» Embedded system

- Brief idea of Embedded Systems & Industrial applications
- Application/Area wise need of Embedded
- Hardware classification for Embedded

» Brain of Embedded Appliances

- Brief idea of Micro-controller/processor
- Why Microcontroller?
- Architecture of Microcontroller
- System architecture – RISC, CISC, Harvard, Von-Neumann
- Architecture of Microcontroller

» Embedded C

- Introduction classes
  - Basic syntax & programming structure
  - Data types, variables & operator
  - if-else & switch selection statement
- Conditional statements or looping
  - While, do-while
  - For, nested-for statements
  - Infinite loops
- C – Array
  - Introduction to array
  - Initialization & defining arrays

» Microcontroller (AVR)

- Features of microcontroller
- Pin out of microcontroller
- GP I/O Port specification
- Description about all Ports
- Description about IDE for programming
- Proteus Simulation for microcontroller
- I/O programming using Embedded C
- Led on/off programming
- Delay generation through function
- Led pattern programming
  - Data shifting from left to right & right to left
  - Curtain open/close programming
  - Even/odd bit toggling
- Sensor interfacing with microcontroller
  - LM35(Temperature Sensor)
  - RFID
  - RF Receiver/T ransmitter
  - Accelarameter
  - IR Sensor
  - Gas Sensor
  - Alchohol Senser
  - Touch Screen
- Motor interfacing
  - Program for controlling direction of DC motor
  - Stepper motor
- 16x2 LCD Display
  - 16x2 LCD command & data register
  - Name/Data printing over LCD
  - Moving message display

» Advanced features of Microcontroller

- TIMER
  - TIMER register explanations
  - Programming of TIMER
- ADC
  - ADC register explanations
  - Programming of ADC
  - Interfacing of temperature sensor
- Serial communication
  - Communication between microcontroller & computer system
- Advance Communication Protocol
  - SPI (Serial Peripheral interface)
  - I2C (Inter integrated circuit)
- Project as per Module

Embedded Systems (ARM)

Introduction to Electronics

- Resistors
- Capacitors
- Diodes
- Transistor
- Transformers
- Power supply

Introduction to Embedded system

- History & need of Embedded System
- Basic components of Embedded System
- Hardware Classification of Embedded System
- Programming Language Classification of Embedded System
- Advantage & Disadvantage of Low level & High level programming language of Embedded System

Microprocessor & microcontroller classification

- Difference between Microprocessor & Microcontroller
- Classification based on architecture
- Classification based on Instruction Set
- Type of Microcontroller
- Introduction to Microcontrollers
- Introduction to Microprocessor
- Other Programmable devices
- Difference b/w various processing devices

Brief introduction to Computer Architecture

- Classification based on architecture
  - Harvard Architecture
  - Von-Neumann
- Classification based on Instruction Set
  - RISC vs. CISC
  - Pipelining in 8051,pic,avr and arm7,arm 9,arm10
  - RISC vs. ARM 32 bit
  - Features of Advance RISC
- Memory Classification and its organization
  - Primary Memory
  - Types of Ram and ROM
  - Secondary Memory

Computer Languages

- Low Level Languages
- Middle Level Language
- High Level Language
- Interaction of language with Compilers

Embedded development tools

- Assembler
- Interpreter
- Compiler
- Simulator
- Emulator
- Debugger

Embedded C programming

- C programming basics
  - Why C
  - Benefits of C over Assembly
  - Constants, V ariables & Data Types
    - Keywords & Identifiers
    - Data type & its memory representation
    - User Define data types (Structure)
    - Array
    - Pointers
  - Operators
    - Arithmetical Operator
    - Logical Operator
    - Bitwise Operators
  - Control Statement and Loops
    - If
    - Switch
    - For
    - While
    - Do While
  - Introduction to preprocessor directives

Introduction to Microprocessor

- Other Programmable devices
- Difference b/w various processing devices

Brief introduction to Computer Architecture

- Classification based on architecture
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  - RISC vs. ARM 32 bit
  - Features of Advance RISC
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Computer Languages

- Low Level Languages
- Middle Level Language
- High Level Language
- Interaction of language with Compilers

Embedded development tools

- Assembler
- Interpreter
- Compiler
- Simulator

- Difference between C and Embedded C
- Compiler handling
- Creating and modifying projects in Compiler Conventional programs
- Basic Embedded programs structure
- Getting your programs into a compiler , writing your programs

» ARM Architecture

- Introduction to ARM Architecture
- Block Diagram
- Functional Diagram
- AMBA bus architecture
- ARM versions
- The endian issue

» Register and memory of ARM7TDMI

- ARM Register Set
- Modes in ARM
- Exception entry and return from dif ferent modes
- 32 bit CPU registers
- CPSR and SPSR register
- States in arm
- ARM naming

» ARM Instruction Set's

- Introduction to 32 bit ARM instruction set
- Introduction to 16 bit THUMB instruction set
- Introduction to 8- bit Jazelle instruction set
- Data processing instruction
- Barrel shifter instruction
- Load and store instruction
- Arithmetic Instruction
- Logical Instruction
- Branching Instruction

» Introduction to LPC21xx series Microcontroller

- Introduction of lpc2000family
- Block diagram description of lpc2148
- Special feature of lpc2148
- Pin description of lpc2148

» Registers & memory of lpc2148

- Description of RAM
- Description of CPU Registers
- Function of SFR

» PIN Control Block

- Pin Configuration
- Pin Connect Block
- General Purpose I/P

» System control block in lpc2148

- Power control programming
- Pll programming
- Vpb programming

» GPIO register and peripheral register

- Gpio register with peripheral speed
- Gpio register with CPU speed
- Pinselect registers

» Interfacing of LED Matrix

- Introduction of LED's
- Brief introduction to P-N Junction Semiconductor Devices and LED
- Circuit Description of Interfacing LED
- Programming of LED's Interfacing
- LED Programming Patterns
- Introduction to common cathode and common anode type Led matrix
- Interfacing hardware of Led matrix
- Programming led matrix
- Introduction to multiplexed led matrix using shifter ic

» Real World Interfacing – Segment Display

- Theory of 7-Segment Displays
- Types of 7 Segment Display
- Writing Decoding Chart for 0-f character
- Writing one digit UP/DOWN Counter Program
- Programming 2 Digit/3 Digit /4 Digit Counter
- TLC (Traffic Light Controller) Programming
- Introduction to Multiplexed 7 segment displays
- Interfacing Multiplexed 7 segment displays
- Theory of 14-Segment Displays
- Writing Decoding Chart for 14 segment character
- Theory of 16-Segment Displays
- Writing Decoding Chart for 16 segment character

» LCD Interfacing

- Block Diagram of LCD
- Types of LCD
- Introduction to 16x1,16 x2 and 16x 4 LCD
- Pin Structure of 16x1,16 x2 and 16x 4 LCD
- Hardware Interfacing Circuit
- LCD Command set
- Commands of 16x1,16 x2 and 16x 4 LCD
- Programming of 16x1,16 x2 and 16x 4 LCD
- To move data on LCD in 8-bit
- To move data on LCD in 4-bit
- To display data on both rows in 4 and 8-bit Mode
- Scrolling message display on LCD in 4 and 8 bits Mode.
- Introduction to graphical LCD

Interfacing of switches & keyboard matrix

- Introduction to Switches & Keyboard Matrix
- Interfacing Circuit of Switches & Keyboard Matrix
- Programming of Keyboard Matrix & Switches
- Controlling of LED's by using Switches
- Key board Matrix & LCD Interfacing Program

Real world interfacing – MOT ORS

- Introduction to Motors
- Introduction to Motors
- Types of Motors used in Embedded System
- AC motor
- DC motor
- Stepper motor
- Servo motor
- DC geared motor
- Programming & Controlling of Motors in Embedded System
- Different kind of Motors
- Interfacing of DC Motors and Stepper Motor
- Motor Drivers Interfacing
    - L293D
    - ULN2003

Motor Controlling circuits

- Motor controlling using driver ICs IC's
- LM358(dual op- amp)
- LM35(Temperature sensor)
- L293D(dual H-bridge IC
- 7805(Voltage regulator)
- Lm317 IC

Types of sensors

- Introduction to Sensing Devices
- IR sensor
- Light searching sensor
- Temperature sensor
- Touch sensor
- Motion sensor

Introduction to signal Decoder IC

- DTMF

Timers & counter programming

- Introduction to Timer & Counter
- Difference between Timer and Counter
- Description of SFR associated with Timer & Counter
- Programming of Timer & Counter
- Timer 0 and Timer 1 Features
- Pin Description
- Basics of Timer Handling
- Capture and match modules in lpc2148

Serial communication programming

- Introduction to the Communication System
- Types of communication System
    - Analog / Digital
    - Serial / Parallel
    - Synchronous/ Asynchronous
- Introduction to Serial Communication
    - Simplex
    - Half Duplex
    - Full Duplex
- Description of SFR associated with Serial Communication
- Data Framing and UAR T Introduction
    - RS232 Protocol
- Introduction & Interfacing of UAR T
    - MAX 232 IC
- Interfacing with PC using UART/RS232

Interrupt driven programming

- Introduction to Interrupts
- Difference between polling and interrupt method
- Types of Interrupts
- Interrupt service routine (ISR)
- Vector Interrupt Control
    - FIQ
    - IRQ
- Programming of Software & Hardware Interrupts
- Interrupt Priority
- Timer Interrupts Programming
- External Hardware Interrupts Programming
- SFR associated with Interrupts
- Programming Serial Interrupts
- RTC interrupt

Interfacing of ADC

- Introduction to ADC
- Registers for ADC
- Interfacing circuit of ADC
- ADC Initialization
- To display digital data on LED
- To display digital data on LCD

Real time clock

- Feathers
- Resister Description
- RTC Interrupts

Pulse width modulation

- PWM Generator
- Register Description
- Application

» Other communication protocols

- Features
- Applications
- Pin Description
- Architecture and Register Description
  - SPI Protocol
    - Introduction to SPI Protocol
    - SPI Protocol Framing
    - Programming of SPI
  - I2C Protocol
    - Introduction to I2C Protocol
    - I2C Protocol Framing
    - Programming of I2C

» Linux Internals & Device Drivers

» Getting Started

- Introduction to Unix and Linux
- Programming Linux
- Linux Compiler
- History of Linux
- Types of Linux platform
- Real time system

» Linux basics and commands

- File Handling
- Text Processing
- System Administration
- Process Management
- Archival
- Network
- File Systems
- Advanced Commands

» Working with file

- Unix file Structure
- File and directory maintenance
- Changing the attributes of a file systems
- File handling concepts
- Normal level file handling
  - Fread
  - Fwrite
  - Fclose
  - Fopen
  - Fseek
- Low level File handling
  - Write
  - Read
  - Open
  - Umask
  - Close
  - lseek

» Processes and Signals

- What is process?
- Process Structure
- The Process Table
- Viewing Processes
- System Processes
- Process Scheduling

» Getting Started

- Kill a process
- Fork
- Starting New Processes
- Waiting for a Process
- Zombie Processes
- Input and Output Redirection
- Execve ,exec ,execv , execlp ,execl ,execve
- Process commands
- Signal handling

» Threads

- What is thread
- Thread programming
- Wait queues
- Spin lock
- Synchronization
  - Synchronization with semaphores
  - Synchronization with mutexes

» Inter-process communication:

» Pipes

- what is pipe
- Process Pipes
- The pipe call
- Parent and child processes
- Named pipes

» Semaphores, message queues and shared memory

- Semaphores
- Semaphore Definition
- Linux Semaphore Facilities
- Using Semaphores

» Shared Memory

- shmget
- shmat
- shmdt
- shmctl

» Message Queues

- msgget
- msgsnd
- msgrcv
- msgctl

Sockets

- What is socket
- Socket connection
- Socket Attributes
- Creating a Socket
- Socket Addresses
- Naming a Socket
- Creating a Socket Queue
- Accepting Connections
- Requesting Connections
- Closing a Socket
- Socket Communications

Device Driver

- An Introduction to Device Drivers
- The Role of the Device Driver
- Splitting the Kernel
- Classes of Devices and Modules
- Security Issues
- Version Numbering
- Overview of the Book
- Building and Running Modules
- Setting Up Your Test System
- The Hello W orld Module
- Kernel Modules V ersus Applications
- Compiling and Loading
- The Kernel Symbol Table
- Preliminaries
- Initialization and Shutdown
- Module Parameters
- Doing It in User Space
- Quick Reference
- 3. Char Drivers
- The Design of scull
- Major and Minor Numbers
- Some Important Data Structures
- Char Device Registration
- open and release
- scull's Memory Usage
- read and write
- Playing with the New Devices