NEHRU MEMORIAL COLLEGE (AUTONOMOUS)

Nationally Accredited with "**A**" Grade by NAAC

PUTHANAMPATTI – 621 007

TIRUCHIRAPPALLI – Dt

SYLLABUS

M.Sc., EMBEDDED SYSTEMS

Post-Graduate Programmes – Course Structure under CBCS
(Candidates admitted from the year 2019 onwards)

DEPARTMENT OF EMBEDDED SYSTEMS

2018

DEPARTMENT OF EMBEDDED SYSTEMS
VISION & MISSION

Vision

- To build a strong foundation and develop the required skill set in students.

- To motivate students are to take up research in their field of interest and full support is provided to design and development of a product.

- To mold students with high Caliber Embedded System Designers by enhancing their knowledge and skills in various hardware and software design aspects of Embedded Systems.

Mission

- Provides an excellent opportunity for those wishing to engage in application research in this rapidly developing area.

- Department of embedded systems into a learning centrewith an excellent academics and research.

PROGRAM SPECIFIC OBJECTIVES

I. The Graduates of Embedded Systems will demonstrate their skills to meet the current and future industrial challenges in the field of embedded systems.

II. The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur.

III. The Graduates of Embedded Systems will undertake a significant research or development of projects.

IV. The graduates will be capable of understanding and implementing the building blocks of real time applications using integrated development environment for automation in the related field.

V. The Graduates of Embedded Systems will exhibit their skills to take-up hardware/software co-design for embedded systems.

VI. Demonstrate outstanding analytical and technical skills to evaluate analyze and solve real time problems in Embedded Systems.

PROGRAM OUTCOMES

The Student of Embedded Systems will be able to:

A. Apply the acquired knowledge from undergraduate courses and other disciplines to identify, formulate and present solutions to technical problems related to various areas of Embedded Systems.

B. Ability to apply knowledge of Mathematics, Physics, Biology, and Electronics to solve complex engineering problems or processes that meet the specific needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

C. Develop confidence, improve their professional value and motivation for self-education and imbibe professional values for lifelong learning.

D. Ability to identify, formulate and solve engineering problems of multidisciplinary nature.

E. Use the techniques, skills, Integrated Development Environment (IDE) tools, operating systems, software and equipment necessary to evaluate and analyze the systems in real time environments.

MAPPING OF PROGRAM SPECIFIC OBJECTIVES WITH PROGRAMME OUTCOMES

A relation between the Program Specific Objectives and the outcomes is given in the table

PROGRAM SPECIFIC OBJECTIVES	PROGRAMME OUTCOMES				
	A	**B**	**C**	**D**	**E**
I	3	3	2	1	2
II	2	3	1	2	3
III	3	2	2	3	2
IV	2	3	3	1	2
V	1	2	2	3	3
VI	3	3	2	2	3

Contribution 1: Reasonable 2: Significant 3: Strong

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Post-Graduate Programmes – Course Structure under CBCS

(Candidates admitted from the year 2019 onwards)

M.Sc., EMBEDDED SYSTEMS

Sem	Course	Sub. Code	Title of the Course	Inst. Hrs/ Week	Credits	Ex. Hrs	Marks		
							Int.	Ext.	Total
I	CC-I		Fundamental of Embedded Systems	6	5	3	25	75	100
	CC-II		Analog Interfacing Devices for Embedded Systems	6	5	3	25	75	100
	CC-III		Design of Embedded Systems with PIC Microcontroller	6	4	3	25	75	100
	CC-IV		PIC Microcontroller Programming Lab	6	3	3	40	60	100
	CC-V		Embedded C Programming Lab	6	3	3	40	60	100
				30	**20**		**155**	**345**	**500**
II	CC-VI		Engineering Mathematics	5	5	3	25	75	100
	CC-VII		Mixed Signal Processors for Embedded Systems	5	4	3	25	75	100
	CC-VIII		AVR Architecture and Programming	5	4	3	25	75	100
	CC-IX		Mixed Signal Processors and AVR Programming Lab	5	3	3	25	75	100
	CEC-I		Candidate has to choose any one of the course from Group- I	6	5	3	25	75	100
	OEC-I		Candidate has to choose any one of the course offered by the Department/ Other Departments (or)Online Course	4	4	3	25	75	100
				30	**25**		**150**	**450**	**600**
III	CC-X		Real Time Operating System with ARM Microcontroller	5	5	3	25	75	100
	CC-XI		Programmable System on Chip	5	4	3	25	75	100
	CC-XII		ARM &PSoC Microcontroller Programming Lab	5	3	3	40	60	100
	CC-XIII		Internship	5	5	-	25	75	100
	CC-XIV		Circuit Design And Simulation Lab	4	3	3	40	60	100
	CEC- II		Candidate has to choose any one of the course from Group–II	6	5	3	25	75	100
				30	**25**		**180**	**420**	**600**
IV	CEC-III		Candidate has to choose any one of the course from Group –III	6	5	3	25	75	100
	CEC-IV		Candidate has to choose any one of the course from Group –IV	6	5	3	25	75	100
	CC- XV		Project	18	10	-	25	75	100
				30	**20**		**75**	**225**	**300**
				120	**90**		**560**	**1440**	**2000**

GROUP– I (SEMESTER-II)

Sub. Code	Title of the Courses	Inst. Hours/ Week	Credits	Marks		
				Int.	Ext.	Total
	Robotics	6	5	25	75	100
	Embedded Networking	6	5	25	75	100
	Hardware Software Co- Design	6	5	25	75	100

GROUP– II (SEMESTER-III)

Sub. Code	Title of the Courses	Inst. Hours/ Week	Credits	Marks		
				Int.	Ext.	Total
	Programming in JAVA	6	5	25	75	100
	Embedded Linux	6	5	25	75	100
	Soft Computing	6	5	25	75	100

GROUP– III (SEMESTER-IV)

Sub. Code	Title of the Courses	Inst. Hours/ Week	Credits	Marks		
				Int.	Ext.	Total
	Python with Raspberry Pi	6	5	25	75	100
	Wireless Sensor Networks	6	5	25	75	100
	Advanced Digital Image Processing	6	5	25	75	100

GROUP– IV (SEMESTER-IV)

Sub. Code	Title of the Courses	Inst. Hours/ Week	Credits	Marks		
				Int.	Ext.	Total
	Internet of Things	6	5	25	75	100
	Advanced ARM Microcontroller	6	5	25	75	100
	Network on Chip	6	5	25	75	100

OPEN ELECTIVE (SEMESTER-II)

Sub. Code	Title of the Courses	Inst. Hours/ Week	Credits	Marks		
				Int.	Ext.	Total
	The 8051 MicrocontrollerArchitecture And Programming	4	4	25	75	100
	Advanced Microcontroller	4	4	25	75	100
	Onlinecourses(MOOC/NPTEL/SWAYAM/e-pathashala	4	4	25	75	100

COURSE DETAIL

Type of Courses	Number of Courses	Inst. Hours/ Week	Credits
Core	15	*92*	*66*
Elective	4	*24*	*20*
Open Elective	1	*4*	*4*
Total	20	*120*	*90*

CORE COURSES

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
I	FUNDAMENTALS OF EMBEDDED SYSTEMS	CC	6	5

Learning Objectives

- ✓ To provide a clear understanding on the Embedded Systems.
- ✓ To teach the fundamentals of Embedded ProcessorModeling, Input/output interfacing
- ✓ To introduce fundamentals of Real time operating system.
- ✓ To involve Discussions/ Practice/Exercise onto revising and familiarizing the concepts acquired over the five units of the subject for improved employability skills.

UNIT-I: Introduction to Embedded Systems

Embedded Systems –Processor Embedded into a System – Embedded Hardware Units and devices in a System – Embedded Software in C System – Embedded System On-Chip – Classification of Embedded Systems – Skills required for an Embedded System Designer.

UNIT-II: Devices and Communication Buses for Devices Network

I/O Types – Serial Communication Devices – Parallel Devices Ports – Wireless Devices – Watchdog Timer – Timer and Counting Devices – Real Time Clock – Serial Bus Communication protocols – parallel Bus Device Protocol.

UNIT-III: Real Time Operating Systems

Introduction to basic concepts of RTOS-Task-process and threads-interrupt routines in RTOS-Multiprocessing and Multitasking, Preemptive and non-preemptive Scheduling-Task communication- shared memory-message passing-Interprocess Communication – synchronization between Processes-Semaphores-Mailbox-pipes-priority inversion-priority inheritance.

UNIT-IV: Software Development Tools

SoftwareDevelopmentenvironment-IDE-assembler-compiler-linker-simulator-debugger-in-circuit Emulator-Target Hardware Debugging-need for Hardware-Software Partitioning and Co-Design.

UNIT-V: Embedded System Application Development

Objectives-different Phases and Modeling of the embedded product Development Life Cycle (EDLC)-Case studies on Smart card- Adaptive Cruise control in a Car -Mobile Phone software for key inputs.

Books for Study:

1. Raj Kamal, "*Embedded Systems Architecture Programming and Design*", TataMcGrew Hill, Second Edition, 2008.
2. Shibu K.V, "*Introduction to Embedded Systems*", McGrew Hill Education,Eight Edition, 2013.

Books for Reference:

1. Steve Heath, "*Embedded Systems Design*", Elsevier Science, Second Edition, 2008.
2. James K.Peckol, "*Embedded system Design*", John Wiley &Sons, 2010.Elicia White,"*Making Embedded Systems*", O'Reilly Series, SPD, 2011.

Course Outcomes

After the completion of this course the student will be able to:

- An ability to design a system, component, or process to meet desired needs within realistic constraints.
- Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems.
- Design real time embedded systems using the concepts of RTOS.
- Foster ability to understand the role of embedded systems in industry.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS

I	ANALOG INTERFACING DEVICES FOR EMBEDDED SYSTEMS	CC	6	5

Learning Objectives

- ✓ To know the fundamentals concept of a digital to analog and analog to digital devices.
- ✓ To get fundamental knowledge of sensors and their operating principles, for measurement of physical quantity.
- ✓ To study the basic principles, configurations and applications of operational amplifier.
- ✓ To get basic idea of control systems and the working principle of electro mechanical devices.

UNIT–I: System Design and Converters

Dynamic Range -Calibration - Bandwidth - Processor Throughput - Avoiding Excess Speed - Other System Considerations -Sample Rate and Aliasing - Digital-to-Analog Converters - Analog-to-Digital Converters - Types of ADCs - Sample and Hold - Real Parts - Microprocessor Interfacing - Serial Interfaces - Multichannel ADCs - Internal Microcontroller ADCs - Codecs - Interrupt Rate.

UNIT–II: Sensors and Measurements

Sensors-Temperature Sensors-Optical Sensors - CCDs - Magnetic Sensors - Motion/Acceleration Sensors - Strain Gauge - Time-Based Measurements - Measuring Period versus Frequency - Mixing - Voltage-to-Frequency Converters - Clock Resolution.

UNIT-III: Control Systems

Open-Loop Control - Negative Feedback and Control - Microprocessor-Based Systems - On-Off Control - Proportional Control - PID Control - Motor Control - Measuring and Analyzing Control Loops.

UNIT-IV: Electromechanical Devices

Solenoids - Heaters -Coolers - Fans - LEDs - Stepper Motors - DC Motors - Brushless DC Motors - Tradeoffs between Motors - Motor Torque - Ground Loops – ESD.

UNIT-V: Operational Amplifier

Op-amp Configurations - General Op-amp Design Equations -Reversing the Inputs - Comparators - Instrumentation Amplifiers - PWM -Standard Interfaces -IEEE 1451.2 and 4-20 mA Current Loop.

Book for Study:

1. Stuart Ball, "*Analog Interfacing to EmbeddedMicroprocessors*" Real World Design, Newnes, USA, 2001.

Books for Reference:

1. Patranabis, D, "*Sensors and Transducers*",PHI Learning Second Edition, 2008.
2. P. Sawhney, "*A Course in Mechanical Measurements and Instrumentation*", Dhanpat Rai &Sons educational and technical, Twelth Edition, 2001.
3. Roy Choudhury, "*Linear Integrated Circuits*", New Age International limited, Second Edition, 2008.

Course Outcomes

Upon successful completion of the course the student will be able to:

- Discuss the op-amp's characteristics, parameter limitations, various configurations and countless applications of op-amp.
- Create analytical design and development solutions for sensors and actuators.
- Applications and selection of sensors for particular application.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
I	DESIGN OF EMBEDDED SYSTEMS WITH PIC MICROCONTROLLER	CC	6	4

Learning Objectives

- ✓ To have knowledge about the basic working of a microcontroller system and its programming in assembly language.
- ✓ To understand the need of microcontrollers in embedded system.
- ✓ To understand the features and architecture of PIC Microcontroller.
- ✓ To learn interfacing of real world input and output devices.

UNIT-I: PIC18 Microcontroller Architecture

Overview of the PIC18 Microcontroller- WREG Register – File register – Status register – PIC data format and directives – Program counter – Instructions: Data transfer instructions – Arithmetic instructions – Logical instructions- Rotate instruction – Branch and Call instructions – simple time delay programs.

UNIT-II: I/O Port Programming

I/O Port programming – I/O bit manipulation programming – Interfacing of LEDs and DAC- Interfacing of DC motor and Stepper motor – LCD interfaces – ADC programming.

UNIT-III: Timer Programming

Programming timers 0 and 1 – Counter Programming - Programming Timers 2 and 3 – square wave generation using timer 0 – time delay program using timer 0- Program for count the pulses.

UNIT-IV: Serial Port Programming and Interrupts

Basics of serial communication – serial port programming – programming the PIC 18 to transfer data serially –receive data serially – PIC18 interrupts – External hardware interrupts – serial communication interrupts.

UNIT-V: CCP and ECCP Programming

Standard and enhanced CCP modules – compare mode programming – Capture mode programming –PWM programming – ECCP programming – PWM motor control with CCP- DC motor control with ECCP.

Book for Study:

1. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey, "*PIC Microcontroller and Embedded Systems Using Assembly and C for PIC 18*", Pearson,2012.

Books for Reference:

1. Han-Way Huang, "*PIC Microcontroller an Introduction to Software and Hardware Interfacing*", Delmar Cengage Learning, New Delhi,2012.
2. Tim Wilmshurst,"*Designing Embedded Systems With PIC Microcontrollers Principles and Applications*", Newness An Imprint of Elsevier, Second Edition,2010.

Course Outcomes

After successfully completing the course students will be able to:

- Learn importance of microcontroller in designing embedded application.
- Describe the PIC18 family microcontroller architectures and its feature.
- Develop interfacing to real world devices.
- Learn use of hardware & software tools.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
I	PIC MICROCONTROLLER PROGRAMMING LAB	CC	6	3

Learning Objectives

- ✓ To introduce students to embedded systems design tools and hardware programmers.
- ✓ Create and debug C program applications using the Microchip MPLAB/micro C integrated development environment (IDE).
- ✓ To develop the skills in both simulation and practical implementation of the basic building blocks of a microcontroller.
- ✓ To Interface PIC18 parallel ports and create programs to perform input/output operations on various devices.
- ✓ To learn the function of timers, counters, PWM generation, CCP module, A/D conversion, and serial communications.

Experiments:PIC Microcontroller

1. Interfacing of LED (Perform arithmetic and logical operations)
2. Interfacing of LCD (Perform special character and Symbols)
3. Interfacing ofStepper Motor
4. ADC programming
5. Digital to Analog Convertor
6. Generation of Waveform in different frequency
7. Counting of pulses
8. Frequency Measurement
9. Serial data transmission and reception
10. Voltage measurement
11. Temperature Measurement
12. Speed control of DC motor using PWM
13. Speed control of DC motor using CCP
14. Implementation of chaotic attractor- Lorenz model
15. Generation of pseudo random number generator

Course Outcomes

By the end of this course

- Get experience with a set of tools for embedded systems programming and debugging.
- Gain hands-on experience in interfacing peripherals to the PIC microcontrollers.
- Configured the PIC18 analog-to-digital converter to measure physical quantities.
- Implementation of several embedded systems with particular focus on the interaction between multiple devices.
- Create an embedded system application.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
I	EMBEDDEDC PROGRAMMING LAB	CC	6	3

Learning Objectives

- ✓ To make the student learn a programminglanguage.
- ✓ To learn problem solvingtechniques.
- ✓ To teach the student to write programs in C and to solve theproblems.

Exercise1: Basics

1. Write a program to print sample strings like "hello world", "Welcome to C Programming" with different formats using escapesequences.
2. Write a Program to print different data types in 'C' and the in ranges.
3. Write a Program to initialize, assignment & printing variables of different data types.

Exercise2: Operators

1. Write a Program to demonstrate arithmetic operators. (+,-,*,/,%)
2. Write a Program to demonstrate logical operators. (logical AND, logicalOR)
3. Write a Program to read radius value from the keyboard and calculate the area of circle and print the result in both floating and exponential notations.
4. Write a Program to calculate simpleinterest.
5. Write a Program to convert temperature. (Fahrenheit –Centigrade andvice-versa).

Exercise3: Operators

1. Write a Program to demonstrate relationaloperators. (<,>,<=,>=,==,!=)
2. Write a program to check equivalence of two numbers using conditionaloperator.
3. Write a Program to demonstrate pre increment and post increment. (++a, a++ where a is a value to be initialized)
4. Write a Program to demonstrate pre decrement and post decrement. (--a, a--where a is a value to beinitialized)
5. Write a program for computing the volume of sphere, cone and cylinder assume that dimensions are integer's use type casting where evernecessary.

Exercise4: Decision Statements

1. Write a Program to read marks of a student in six subjects and print whether pass or fail (usingif-else).
2. Write a Program to calculate roots of quadratic equation (usingif-else).

Exercise5: Switch Operations

1. Write a Program to perform arithmetic operations using switchcase.
2. Write a Program to display colors using switch case(VIBGYOR).
3. Write a Program to display vowels and consonants using switchcase.
4. Write a Program to display names of days in a Week using switchcase.

Exercise6: Basic Loop Operations

Do the Following Programs Using for, while, do-while loops.

1. Write a program to calculate sum of individual digits of a givennumber.
2. Write a program to check whether given number is palindrome ornot.
3. Write a program to print prime numbers in the givenrange.
4. Write a program to display multiplication tables from 1 to 10 except 3 and5.

Exercise7: 1-D Arrays

1. Write a program to store 10 elements in the 1-D array and print sum of thearray.
2. Write a program to print minimum and maximum elements in the 1-Darray.
3. Write a program to count no. of positive numbers, negative numbers and zeros in the array.
4. Write a program to search the given element by using linearsearch.
5. Write a program to sort the given elements using bubble sorttechnique.

Exercise8: 2-D Arrays

1. Write a program to perform matrix addition and matrixsubtraction.
2. Write a program to perform matrix multiplication by checking thecompatibility.
3. Write a program to print the transpose of amatrix.

Exercise9: Strings

1. Write a program to perform various string manipulations using built-infunctions.
2. Write a program to print the given strings in ascendingorder.
3. Write a program to verify the given string is palindrome or not (without built-in functions, with using built-infunctions).
4. Write a program to concatenate two strings usingarrays.

Exercise10: Math Functions and I/O Functions

1. Write a program to read values from keyboard and find the values using abs(),sqrt(),floor(),ceil()and pow().
2. Write a program to read and display a value using getch() andputch().
3. Write a program to read and display a value using getchar(), putchar(),gets()and puts().

Exercise11: Functions

1. Write a program to find sum of two numbers usingfunctions.
2. Write a program functions without arguments, without returntype.
3. Write a program without arguments, with return type.
4. Write a program functions with arguments &without return type.
5. Write a program functions with arguments, with return type.

Exercise12: Functions and Recursion

1. Write a program to swap two numbers using A) Call by Value B) Call by Reference.
2. Write a program to calculatefactorial,gcd using recursion andnon-recursion functions.
3. Write program to perform arithmetic operations usingpointer.
4. Write a program matrix addition usingpointers.

Exercise13: Structures

1. Write a program to create structure for an account holder in a bank with following Fields: name, account number, address, and balance and display the details of five accountholders.
2. Writeaprogramtofindtotalmarksofindividualstudentandaverage marks for 10 students usingstructures.
3. Write a program to create structure called traveler and members of structure are train no, coach no, seat no, source, destination, gender, age, name and departure date.
4. Write a program to illustrate passing an entire structure to afunction.

Exercise14: File operations using command line arguments

1. Write a program which copies the contents of one file to another file using command line arguments.
2. Write a program to reverse the first n characters in a file use command line arguments.

Books for Study:

1. YashavantKanetkar, "*Let Us C Work Book*", BPB publications, 9th Edition, 2010.
2. T. Jeyapoovan "A First Course C Programming" Vikas Publishing House,1st Edition,2002.

Books for Reference:

1. Brain W. Kernighan, Dennis M.Ritche," *The C Programming Language*", PHI,2ndEdition, 2012.
2. Ram Kumar, Rakesh Agrawal,*Programming in ANSI C*",West Publishing Company,1992.
3. Yashavant Kanetkar,"*Test Your C Skills*", 1 Jan 2002.

Course Outcomes

After Completion of this course the student would be able to:

- Read, understand and trace the execution of programs written in Clanguage.
- Write the C code for a givenalgorithm.
- Implement Programs with pointers and arrays, perform pointer arithmetic, and use thepre-processor.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
II	ENGINEERING MATHEMATICS	CC	5	5

Learning Objectives

- ✓ To explain the concept and solve the differential equation.
- ✓ Finds Laplace transforms solution of linear differential equation.
- ✓ Use the basic concepts of linear algebra and vector calculus.
- ✓ Understand the properties of Fourier series and probability.

UNIT-I: Ordinary Differential Equations

Basic Concepts and Ideas – Geometrical meaning of y'= f(x,y) – Direction Fields – Separable Differential Equations – Modeling: Separable Equations – Exact Differential Equations - Integrating Factors- Linear Differential Equations – Bernoulli Equations – Modeling: Electric circuits – Homogeneous Linear Equations of Second Order – Second-Order Homogenous Equations with Constant Coefficients .

UNIT-II: Laplace Transforms

Laplace Transform – Inverse Transform – Linearity – Shifting – Transforms of Derivatives and Integrals – Differential Equations – Unit Step Function – Second Shifting Theorem –Dirac's Delta Function – Differentiation and Integration of Transforms – Convolution – Integral Equations – Partial Fractions – Differential Equations – Systems of Differential Equations.

UNIT-III: Linear Algebra, Vector Calculus

Basic Concepts – Matrix Addition – Scalar Multiplication - Matrix Multiplication – Linear Systems of Equations – Rank of Matrix – Determinants – Cramer's Rule – Inverse of a Matrix – Gauss-Jordian Elimination – Eigenvalues - Eigenvectors – Symmetric – Skew-symmetric – Orthogonal Matrices – Complex Matrices: Hermitian – Skew-Hermitian – Unitary – Similarity of Matrices – Basic of Eigenvectors – Diagonalization.

UNIT-IV: Fourier analysis

Periodic Functions – Trigonometric Series – Fourier Series – Functions of Any Period p =2L – Even and Odd Functions – half-Range Expansions – Fourier Cosine and Sine Transforms – Fourier Transform – Basic Concepts.

UNIT-V: Statistics

Data: Representation - Average – Spread – Experiment – Outcomes – Events – Mean- Median-Mode-Probability – Permutations – Combinations – Random Variable – Probability Distribution – Binomial – Poisson– Normal Distribution.

Book for Study:

1. ERWIN KREYSZIG, "*Advanced Engineering Mathematics*", John – Wiley, Singapore, 2005.

Books for Reference:

1. Taha, H.A., "*Operations Research, An introduction*", Pearson education, Tenth Edition, New Delhi, 2010.
2. Andrews L.C. and Phillips R.L., "*Mathematical Techniques for Engineers and Scientists*", Prentice Hall of India Pvt.Ltd., New Delhi, 2005.
3. J. L. Hodges, Jr. and E. L. Lehmann "*Basic Concepts of Probability and Statistics*" Society for Industrial and Applied Mathematics (SIAM), 2005.

Course Outcomes

After the completion of this course the student will be able to:

- Recognize the relationships between different areas of mathematics and the connections between mathematics and other disciplines.
- Use computational techniques and algebraic skills essential for the study of systems of linear equations, matrix algebra, eigenvalues and eigenvectors.
- Develop Fourier series for different types of functions.
- Understanding of elementary probability theory and its applications.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
II	MIXED SIGNAL PROCESSOR FOR EMBEDDED SYSTEMS	CC	5	4

Learning Objectives

- ✓ To learn basic interface between computing systems and real-world devices.
- ✓ To demonstrate knowledge by performing exercises using a MSP430 Microcontroller training board connected to real-world I/O.
- ✓ To learn MSP430 Microcontroller and low power features.
- ✓ To learn interfacing of real world input and output devices.

UNIT-I: MSP430 Architecture

Introduction Functional block diagram – Memory– Central Processing Unit–Memory Mapped Input and Output– Clock Generator– Exceptions: Interrupts and Resets–MSP430 family.

UNIT-II: Addressing Modes and Instruction Set

Addressing Modes – Instruction set–Constant Generator and Emulated Instructions– Program Examples.

UNIT-III: Clock System, Interrupts and Operating Modes

Clock System– Interrupts– What happens when an interrupted is requested– Interrupt Service Routines–Low Power Modes of Operation– Watchdog Timer–Basic Timer1– Real Time Clock– Timer-A– Timer Block, Capture/Compare Channels–Interrupts from Timer-A.

UNIT-IV: Analog Input-Output and PWM

Comparator-ADC10– ADC12– Sigma-Delta ADC– Internal Operational Amplifiers– DAC–Edge Aligned PWM–Simple PWM and Design of PWM.

UNIT-V: Digital Input-Output and Serial Communication

Parallel Ports–Lighting LEDs– Flashing LEDs– Read Input from a Switch– Toggle the LED state by pressing the push button– LCD Interfacing-Asynchronous Serial Communication– Asynchronous Communication - Peripherals in MSP430– Serial Peripheral Interface.

Book for Study:

1. John H Davies, "*MSP430 Microcontroller Basics*", Newnes Publications, Elsevier, 2008.

Books for References:

1. Chris Nagy, "*Embedded Systems Design using TI MSP430 Series*", Newnes Publications, Elsevier,2003.
2. http://www.ti.com/lit/ug/slau144j/slau144j.pdf.

Course Outcomes

At the end of the course student will be able to learn:

- Describe the MSP architectures and its feature.
- Embedded C programming techniques for 16-bit platform.
- Interface the advanced peripherals to MSP.
- Embedded protocols and its interfacing techniques for mixed signal processors.
- Design embedded system with available resources for simple applications using MSP.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
II	AVR ARCHITECTURE AND PROGRAMMING	CC	5	4

Learning Objectives

- ✓ To teach students design and interfacing of AVR microcontroller-based embedded systems.
- ✓ To know the concept of interface with peripheral devices.
- ✓ To understand the function of timers, counters, interrupts and serial communication programming using AVR Studio.

UNIT–I: Introduction to AVR Microcontroller

History of the AVR Family – Features of AVR Family – Architecture – General Purpose Register-Data Memory – AVR Status Register – Program Counter and Program ROM Space in the AVR-RISC Architecture in the AVR.

UNIT-II: Instruction Set

Data Transfer Instructions – Bit and Bit Test Instructions – Arithmetic and Logical Instructions – MCU Control Instruction - Addressing Modes – Simple Programs: Addition – Subtraction – Multiplication – Division.

UNIT-III: I/O Programming and Timers

ATMega32 Pin connection – I/O Port pins and their functions – DDR Role – I/O Bit Manipulation and Programming – Timers: TCCR0 Register – TIFR Register – Time Delay Calculation – Prescaler and generating a large time delay - Timer0, Timer1, and Timer 2 Programming Concept – Counter Programming.

UNIT-IV: Interrupts and Serial Communication

AVR Interrupts – Programming Timer Interrupts – Programming External Hardware Interrupts Interrupts Priority – Interrupt Programming in C – Simple Programs using Interrupts - AVR Serial Port Programming – Serial Port Register – Simple Program to Transfer and Receive Data Serially.

UNIT-V: Interfacing Techniques using AVR Studio

LCD Interfacing – Keyboard Interfacing – ADC programming in AVR – Interfacing the LM34 to the AVR – Waveform Generator – using Timer – DC Motor – MAX 7221 Interfacing and Programming (Seven Segment Display).

Book for Study:

1. Muhammad Ali Mazidi"*The AVR Microcontroller and Embedded Systems Using Assembly and C*", Prentice Hall, 2010.

Book for Reference:

1. Steven Frank Barrett, Daniel J. Pack, "*Atmel AVR Microcontroller Primer: Programming and Interfacing*", Morgan & Claypool Publishers, 2008.

Course Outcomes

After taking this course, students should be able to:

- Design and development the electronic systems based on AVR microcontrollers.
- Know how to write code to interface to sensors/devices with various communication protocols.
- Install the development software and program on AVR microcontroller.
- Foster ability to understand the design concept of embedded systems.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
II	MIXED SIGNAL PROCESSORS AND AVR PROGRAMMING LAB	CC	5	3

Learning Objectives

- ✓ To provide in depth knowledge of AVR family microcontroller and MSP430 Assembly language programming.
- ✓ To expertise working with AVR studio and Keil compiler and embedded C programming.
- ✓ To impart the I/O interfacing concepts for developing real time embedded systems.
- ✓ To encourage the students in building real time applications.

Experiments

MIXED SIGNAL PROCESSORS

1. Interfacing of LED Using Timer Functions
2. Interfacing of LCD
3. Interfacing of Stepper motor
4. Analog to Digital Convertor
5. Interfacing of DC Motor Using Pulse Width Modulation
6. RTC (Real Time Clock)
7. UART
8. SPI
9. I^2C

AVR MICROCONTROLLER

1. Interfacing of LED
2. Interfacing of LCD Display with Special character and Symbols
3. Interfacing of Seven Segment Display
4. Interfacing of Stepper Motor
5. Analog to Digital Convertor
6. Generating Square Wave using Timer
7. Object Count using LDR/IR Sensor
8. Interfacing of Keyboard
9. Interfacing of RTC
10. Pressure Measurement
11. DC Motor Control using Pulse Width Modulation.
12. Implementation of EEPROM Read and Write
13. Interrupt Programming

Course Outcomes

Upon completion of the lab course, students will be able to:

- Familiarize with the assembly level and embedded C programming using AVR studio and Keil compiler.
- Understand the concept of mixed signal processing and processor.
- Develop system to transfer data to one device to another device.
- Apply the concepts on real- time applications.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
III	REAL TIME OPERATING SYSTEMS WITH ARM MICROCONTROLLERS	CC	5	5

Learning Objectives

- ✓ To describe the architecture of ARM processor.
- ✓ To design system in block level using microcontroller, memory devices, buses and other peripheral devices.

UNIT-I: Cortex-M Processor Architecture

Computer architecture - Cortex-M processor architecture- TM4C123 Launch pad I/O pins – Addressing modes – memory access instructions – logical operations – shift operations – Arithmetic operations – Functions and control flow – Stack usage.

UNIT- II: Design of I/O Interfaces and Software Design

Parallel I/O ports – Phase Lock Loop – NVIC on the ARM – SysTick Timer –Configuring digital output pins – UART interface – Synchronous transmission and receiving using the SSI - Memory management and the Heap – Threads – First in First Out Queue – Inter thread communication and synchronization – Debugging.

UNIT- III: Real Time Operating Systems

Fundamentals – Round Robin Scheduler – Semaphores – Thread synchronization and communication – Monitors – Fixed Scheduling –OS considerations for I/O devices.

UNIT- IV: Digital Signal Processing

Basic principles – Audio Input/output – Multiple Access Circular Queue – Using the Z – transform to Derive filter response – IIR Filter Design – Discrete Fourier transform – FIR filter design.

UNIT- V: High Speed Interfacing

The need for speed – High speed I/O applications – General approaches to High speed interfaces – Fundamental approach to DMA – Programming Flash EEPROM – Secure Digital Card interface.

Book for Study:

1. Real Time Operating Systems for ARM Cortex-M Microcontrollers, Jonathan W.Valvano, Second Edition, Createspace Independent Pub,2014.

Books for Reference:

1. Andrew N.Sloss, Dominic Symes and Chris Wright, "ARM system Developers guide – Designing and optimizing system software", Elsevier, 2012.
2. Steve Furber, "ARM System-On-Chip", 2nd Edition, Pearson, 2013.

Course Outcomes

Upon completion of the course, students should be able to:

- Describe the architecture of processors.
- Develop program displaying digital logic and mathematics ARM instruction set.
- Solve real time problem and construct a complete system as a solution.
- Integrate and build a working model using the laboratory components and IDE tools.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
III	PROGRAMMBLE SYSTEM ON CHIP	CC	5	4

Learning Objectives

- ✓ To know the top level architecture of cortex M3 processors.
- ✓ To understand the concepts of PSoC and internal resource.
- ✓ To learn the concepts of timer counter,PWM blocks.
- ✓ To know the function of analog to digital blocks.

UNIT-I: Overview of Cortex M3 Microcontroller

Top Level Architecture – Features – CPU System – Memory – System Wide Resources – Digital System – Analog System – Cortex – M3 Microcontroller – Features Registers – Operating Modes -Pipelining – Thumb – 2 Instruction Set – Memory Map – Nested Vector Interrupt Controller – PSoC 5LP Cache Controller – PHUB and DMA Controller.

UNIT-II: System Wide Resources and I/O System

Clocking System – Features – Internal Oscillator – External Oscillator – Clock Distribution – Clock Divider – I/O System – I/O Drive Modes – Digital I/O Controlled – By Port Register and DSI – Analog I/O – LCD Drive – Cap Sense – Port Interrupt – Controller Unit.

UNIT-III: Timer, Counter, PWM, Digital Filter Block

Features – Working of Timer - Pulse Width Modulator – Operating Modes – I^2C – Working – Programming - Digital Filter Block Working.

UNIT-IV: Analog System

Switched Capacitor – Working – Operating Modes – Comparators – Operational Amplifier– LCD Direct Drive – Cap Sense – Working – Programming.

UNIT-V: DAC and ADC

Digital to Analog Convertor – Current DAC – Voltage DAC – Delta Sigma Modulator – Analog Interface – Decimator – ADC Conversion Time – Successive Approximation Register ADC - Programming.

Books for Study:

1. *PSoC® Programmable System-on-Chip, Technical Reference Manual,* Document No.001-78426, Cypress Semiconductor Corporation, USA.
2. Robert Asdhy,*" Designer's Guide to the Cypress PSoC",* Elsevier, First Edition, 2005.

Book for Reference:

1. PredragMićaković,"*Architecture and Programming of PSoC Microcontrollers*", mikroElektronika.

Course Outcomes

The students will be able to:

- Under the concept of PSoC systems.
- Configured the hardware and software co-design.
- Implementation of PSoC system to any applications.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS

III	ARM AND PSoC PROGRAMMING LAB	CC	5	3

Learning Objectives

- ✓ To study programming of ARM Cortex M4 Processor using Keil IDE and Code Composer Studio (CCS) software.
- ✓ To Familiarization with Tiva C series Launchpad.
- ✓ To know the mechanism to load program and execute it on Launchpad.
- ✓ To learn the functional block of PSoC.
- ✓ To reconfigure analog and digital system in PSoC creator.

Experiments

ARM Programming for:

1. Interfacing of LED
2. Timer Programming
3. Graphical LCD Interfacing
4. Analog to Digital Interface
5. Voltage Measurement.
6. Interrupt Programming
7. Serial Communication - USB
8. Implementation of PLL
9. Implementation of Round Robin Scheduler
10. Implementation of Thread Synchronization and Communication
11. Implementation of IIR Filter Design and FIR Filter Design
12. Interfacing of SD Card
13. Implementation of Programming flash EEPROM

PSoC Programming for:

1. ADC Differential Mode
2. ADC – SAR – PRISM
3. ADC – Single Ended Mode
4. CAN Control System
5. Capacitive Keyboard –Design
6. LCD – Custom Font Display
7. Inverting and Non Inverting Amplifier Implementation
8. Design of Counter
9. Multi-Channel Data Acquisition Systems
10. Design – I^2CModule
11. Design – SPIModule
12. Implementation of PGA System
13. DAC- Voltage and Current Mode

Course Outcomes

At the end of the course, the students will be able to

- Understand the Procedure to execute programs with a simulator by using an IDE
- Develop simple and complex programs.
- Interface external peripheral devices to ARM cortex M4 processor.
- Understand the interfacing of I/O devices to tiva 123/129 launch pad.
- Configured the analog and digital system of PSoC.
- Develop real time embedded system applications.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
III	INTERNSHIP	CC	5	5

Internship

For the students pursuing Internship:

- ✓ Internships to be considered as one to three months of supervised project work carried out at industry.
- ✓ Internship committee will get necessary documents from the industry.
- ✓ The internship committee will ensure that a feedback is collected from every student pursuing internship to ensure progress towards completion.
- ✓ At the time of internship completion, the internship committee will also collect the certificate from the concerned person of the organization.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
III	CIRCUIT DESIGN AND SIMULATION LAB	CC	4	3

Learning Objectives

- ✓ This is a basic course for designing of PCB using software.
- ✓ To analyze and interpret test results and measurements on electric circuits.
- ✓ To predict the performance of electric circuits from device characteristics.
- ✓ To design an electronic printed circuit board for a specific application using industry standard software.

EXPERIMENTS

1. Introduction to PCB and OrCAD software
2. Getting Familiar with OrCAD and designing of schematic
3. Designing of capture from OrCAD and getting positive for PCB manufacturing
4. Soldering shop: Fabrication of DC regulated power supply
5. PCB Lab: (a) Artwork & printing of a simple PCB(b) Etching & drilling of PCB
6. Testing of regulated power supply fabricated
7. Design and simulation of phase shift oscillator
8. Design and simulation of active filters
9. Design and simulation of instrumentation amplifier
10. Design and simulation of inverting and non-inverting amplifier
11. Design and simulation of monostable and astable multivibrator
12. Design and simulation of integrator and differentiator
13. Simulation analysis of series RLC circuits
14. Simulation of ac and dc circuits

Course Outcomes

At the successful completion of this course, the student is expected to gain the following skills:

- Become familiar with the basic circuit components and know how to connect them to make a real electrical circuit.
- Able to gain practical experience related to electrical circuits, stimulate more interest and motivation for further studies of electrical circuits.
- Able to carefully and thoroughly document and analyze experimental work.

ELECTIVE COURSE

GROUP - I

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
II	ROBOTICS	CEC	6	5

Learning Objectives

- ✓ To introduce robot terminologies and robotic sensors to educate direct andinverse kinematicrelations.
- ✓ To educate on formulation of manipulator Jacobians and introduce path planning techniques.
- ✓ To educate on robotdynamics.
- ✓ To introduce robot controltechniques.

UNIT-I: Introduction

Serial Robots Subsystems-Applications-Coordinate System-Actuation System-Control Method-Programming Method-Actuators-Sensors-Sensor Classification-Internal Sensor-External Sensor-Vision System-Sensor Selection.

UNIT-II: Transformations and Kinematics

Robot Architecture-Pose of a Rigid Body-Coordinate Transformation-Denavit and Hardenberg (DH) Parameters-Forward Position Analysis-Inverse Position Analysis-Velocity Analysis.

UNIT-III: Statics and Dynamics

Force and Moment Balance-Recursive Calculation-Equivalent Joint Torques-Role of Jacobian in Statics -Inertia Properties-Euler-Lagrange Formulation-Newton-Euler Formulation-Recursive Newton-Euler Formulation-Dynamics Algorithm.

UNIT-IV: Recursive Robot Dynamics and Control

Dynamic Modeling-Analytical Expressions-RIDIM-Recursive Forward Dynamics and Simulations-Control Techniques-Second Order Linear Systems-A Robotic Joint-Joint Controller-Non-Linear Trajectory Controls.

UNIT-V: Motion Planning and Computers for Robots

Joint Space Planning-Cartesian Space Planning-Position and Orientation Trajectories-Point-To-Point Planning-Continuous Path Generations-ComputationalSpeed-Hardware Requirements-Control Considerations-Robot Programming-Hardware Architecture.

Books for Study:

1. S.K SAHA *"Introduction of Robotics"* Published by McGraw Hill Education(India)Private Limited ,2013.
2. G.Kavlivarathan and C.Aravind ,*"Robotics"*Published by Anuradha Publications,2015.

Books for References:

1. R.K. Mittal and I J Nagrath, *" Robotics and Control",* Tata MacGraw Hill, Fourthedition.
2. Saeed B. Niku ,''*Introduction to Robotics* '',Pearson Education, 2002.
3. Fu, Gonzalez and Lee Mcgrahill ,''*Robotics* ", internationaledition.
4. R.D. Klafter, TA Chmielewski and Michael Negin, "*Robotic Engineering*, AnIntegrated approach",Prentice Hall of India,2003.

Course Outcomes

Upon completion of the lab course, students will be able to:

- Understand the components and basic terminology ofRobotics.
- Ability to model the motion of Robots and analyze the workspace and trajectory panning ofrobots.
- Develop application basedRobots.
- Formulate models for the control of mobile robots in various industrial applications.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
II	EMBEDDED NETWORKING	CEC	6	5

Learning Objectives

- ✓ To understand the significance of embedded networks in real time applications and to use it for specific applications.
- ✓ To know different types of communication protocols like serial and parallel communication protocols.
- ✓ To know different types of communication protocols which have embedded end modules
- ✓ To understand wired and wireless communication protocols.
- ✓ To understand and gain knowledge on wireless sensors and its application in wireless embedded networks.

UNIT–I: Embedded Communication Protocols

Embedded Networking: Introduction – Serial/Parallel Communication – Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming - ISA/PCI Bus protocols – Fire wire.

UNIT–II: USB and CAN Bus

USB bus – Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets –Data flow types –Enumeration –Descriptors–CAN Bus – Introduction - Frames –Bit stuffing –Types of errors –Nominal Bit Timing –PIC microcontroller CAN Interface –A simple application with CAN.

UNIT–III: Ethernet Basics

Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed – Design choices: Selecting components –Ethernet Controllers – Using the internet in local and internet communications – Inside the Internet protocol.

UNIT–IV: Embedded Ethernet

Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure.

UNIT–V: Wireless Embedded Networking

Wireless sensor networks – Introduction – Applications – Network Topology – Localization – Time Synchronization - Energy efficient MAC protocols –SMAC – Energy efficient and robust routing –Data Centric routing.

Books for Study:

1. Frank Vahid, TonyGivargis, John Embedded Systems Design:" *A Unified Hardware/Software Introduction"*& Wiley Publications, 2002
2. -Jan Axelson, "*Parallel Port Complete: Programming, interfacing and using the PCs"* parallel printer port Penram Publications, 1996.

Books for Reference:

1. Jan Axelson,"*Embedded Ethernet and Internet Complete*", Penram publications, 2003.
2. BhaskarKrishnamachari, "*Networking Wireless Sensors*",Cambridge press 2005.

Course Outcomes

After taking this course, students should be able to:

- Understand the basic concept of network and types of communication protocol.
- Understand the significance of embedded networks in real time applications and to use it for specific.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
II	HARDWARE SOFTWARE CO- DESIGN	CEC	6	5

Learning Objectives

- ✓ To acquire the knowledge about system specification and modeling.
- ✓ To learn the formulation of partitioning.
- ✓ To analyze about co-synthesis.
- ✓ To study the different technical aspects about prototyping and emulation.

UNIT- I: Specification of Embedded Systems

Introduction to co-design-comparison of co-design approaches -MoCs: state oriented-activity oriented-structure oriented-data oriented and heterogeneous-software CFSMs-processor-characterization.

UNIT -II: Hardware/Software Partitioning and Tradeoffs

Cost modelling-principle of hardware/software mapping-real time scheduling-design specification and constraints on embedded systems-tradeoffs

UNIT- III: Hardware/Software Partitioning Methodologies and Co-Synthesis

Partitioning Granularity-Kernigan-lin algorithm-extended partitioning-binary partitioning: GCLP algorithm-software synthesis-hardware synthesis-interface synthesis-co-synthesis approaches:Vulcan, Cosyma, Comos, Polis and COOL.

UNIT –IV: Hardware Software Estimation

Hardware area-execution timing and power-software memory and execution timing-worst case execution time**.**

UNIT -V: Co- Simulationand Co- Verification

Principles of co-simulation-abstract level-detailed level-co-simulation as partitioning support-co-simulation using Ptolemy approach-virtual prototyping.

Books for Study:

1. Jorgen Staunstrup, Wayne Wolf, *"Hardware / Software Co- Design Principles and Practice"*, Springer, 2009.
2. Ralf Niemann , "*Hardware/Software Co-Design for Data Flow Dominated Embedded Systems*", Kluwer Academic Pub, 1998.

Books for Reference:

1. Kluwer, *"Hardware / Software Co- Design Principles and Practice",* Academic publishers, 2002
2. Giovanni De Micheli , Rolf Ernst Morgon," *Reading in Hardware/Software Co-Design*" Kaufmann Publishers,2001.

Course Outcomes

After taking this course, students should be able to:

- Assess prototyping and emulation techniques.
- Compare hardware / software co-synthesis.
- Formulate the design verification and validate its functionality by simulation.

GROUP - II

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
III	PROGRAMMING IN JAVA	CEC	6	5

Learning Objectives

- ✓ To familiarize the Object Oriented Programming (OOP) concepts, such as abstraction, encapsulation, instances, initializations, polymorphism, overloading, inheritance and generic programming.
- ✓ To learn the OOP specific programming languages in Java.
- ✓ To write programs to solve problems using the OOP language constructs rather than structural programming.
- ✓ To understand and know the importance of OOP in real-world problems.

UNIT-I: Overview of Java

Object Oriented Programming –The Three OOPs Principles- lexical – white space – identifiers – Literals – Comments – separators – The Java Keywords-Primitive Types – Type Conversions and Casting – Operators –Control Statements-Array.

UNIT-II: Class and Objects, Exception Handling

Class Fundamentals – Methods Introduction – Object Declaration –Constructors – The finalize Method - Method overloading – Method overriding – Inheritance- Exceptions basics - Types of Exception – try and catch – Nested try – throw and throws. I/O Basics – Reading console input – Writing Console Output – Reading and Writing Files.

UNIT-III: Servlet

Servlet Overview and Architecture-Interface Servlet and the Servlet Life Cycle- Handling HTTP get Requests-Handling HTTP post Requests-Redirecting Requests to Other Resources-Session Tracking-Cookies-Session Tracking with Http Session.

UNIT-IV: Swing and Graphics Programming

Web browser using JEditorPane and JToolBar-Swing Actions-JSplitPane and JTabbedPane-Multiple-Document Interface-Drag and Drop-Internationalization-Accessibility-Internet and World Wide Web Resources-Graphics Programming with Java 2D and Java 3D.

UNIT-V: Collections and JDBC

Collection Interface-Sets-Queues-Deque-Lists-Maps-Structured Query Language -Databases with JDBC-Prepared Statements-Transaction Processing.

Books for Study:

1. Joycefarrell , *"Java$_{tm}$Programming"* Course Technology, Inc ,Eighth Edition ,2016.
2. H. M.Deitel, P. J. Deitel, S. E. Santry , *"Advanced Java 2 Platform How To Program"*Prentice Hall, Prentice Hall, Second edition, 2007.
3. O'Reilly,O'Reilly Media ,"Java Generics and Collections" 1st Edition,2007.

Book for Reference:

1. Antonio Goncalves,"Beginning Java EE 6 Platform with GlassFish 3" Apress Publication,2009.

Course Outcomes

Upon completion of the course, the students will be able to:

- Design problem solutions using Object Oriented techniques.
- Apply the concepts of data abstraction, encapsulation, polymorphism, overloading, and inheritance for problem solutions.
- Use the OOPs concepts of Java appropriately in problem solving.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
III	EMBEDDED LINUX	CEC	6	5

Learning Objectives

- ✓ To provide an understanding of essentials of embedded Linux.
- ✓ To understand the complexities of Embedded Linux Distributions in embedded systems.
- ✓ Explain the essential components- tool chain, kernel, boot loader and root file system.

UNIT-I: Fundamentals of Linux

Basic Linux System Concepts: Working with Files and Directories - Introduction to Linux File system - Working with Partitions and File systems - Understanding Linux Permissions; Using Command Line Tools: Executing Commands from the Command Line - Getting to a Shell - Popular Command-Line Commands - Working with the Bash Shell.

UNIT-II: Various Distributions and Cross Platform Tool Chain

Introduction - History of Embedded Linux - Embedded Linux versus Desktop Linux - Commercial Embedded Linux Distribution - Choosing a distribution - Embedded Linux Distributions - Architecture of Embedded Linux - Linux Kernel Architecture - Porting Roadmap - GNU Cross Platform Tool chain.

UNIT-III: Host-Target Setup and Overall Architecture

Real Life Embedded Linux Systems - Design and Implementation Methodology - Types of Host/Target Development Setups - Types of Host/Target Debug Setups - Generic Architecture of an Embedded Linux System - System Startup - Types of Boot Configurations - System Memory Layout - Processor Architectures - Buses and Interfaces - I/O – Storage.

UNIT-IV: Kernel Configuration

A Practical Project Workspace - GNU Cross-Platform Development Toolchain - C Library Alternatives - Other Programming Languages - Eclipse: An Integrated Development Environment - Terminal Emulators - Selecting a Kernel - Configuring the Kernel - Compiling the Kernel - Installing the Kernel - Basic Root FileSystem Structure - Libraries - Kernel Modules and Kernel Images - Device Files - Main System Applications - System Initialization.

UNIT–V: Linux Drivers

Introduction in to basics on Linux drivers, introduction to GNU cross platform Toolchain-Case study on programming one serial driver for developing application using Linux.

Books for Study:

1. P.Raghavan,SriramNeelakandan, *"Embedded Linux System Design and Development"*,Auerbach Publications, 2012
2. Karim Yaghmour, Jon Masters, Gilad Ben-Yossef, and Philippe Gerum, "*Building Embedded Linux Systems 2nd Edition"*, SPD -O'Reilly Publications, 2008.

Books for References:

1. William von Hagen, "*Ubuntu Linux Bible 3rd Edition"*, Wiley Publishing Inc., 2010
2. Jonathan Corbet, Alessandro Rubini& Greg Kroah-Hartman, "*Linux Device Drivers 3rd Edition"*, SPD -O'Reilly Publications, 2011
3. Robert Love,*"Linux System Programming"*, SPD -O'Reilly Publications, 2010.

Course Outcomes

At the end of this course, students will be able to:

- Understand the development of environment setup.
- Learn about drivers and kernel development.
- Learn to configure and build a customized Linux kernel.
- Grasp the concept of modern Linux for embedded systems.
- Create and test programs that perform I/O and networking application.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
III	SOFT COMPUTING	CEC	6	5

Learning Objectives

- ✓ To learn the key aspects of neural networks and fuzzy logic.
- ✓ To familiarizes with the design of various neural networks.
- ✓ To understand the features of neural network fuzzy logic and its applications.
- ✓ To gain insight onto Neuro Fuzzy modelling and control systems.

UNIT –I: Introduction to Artificial Neural Networks

Artificial neural networks and their biological motivation – Terminology – Models of neuron –Topology – characteristics of artificial neural networks – types of activation functions. Learning Laws: Learning methods – error correction learning – Hebbian learning – Perceptron – XOR Problem –Perceptron learning rule convergence theorem – Adaline

UNIT –II: Feed forward networks

Multilayer Perceptron – Back Propagation learning algorithm – Universal function approximation – Associative memory: auto association-heteroassociation-recall and cross Talk-Recurrent neural networks: Linear auto associator – Bi-directional associative memory – Hopfield neural network – Traveling Salesman Problem

UNIT- III: Unsupervised Learning

Competitive learning neural networks – Max net – Mexican Hat – Hamming net. Self-Organizing networks: Kohonen Self organizing Feature Map – Counter propagation – Learning Vector Quantization Adaptive Resonance Theory- Applications of neural networks in image processing signal Processing- modeling and control.

UNIT-IV: Fuzzy Sets and Fuzzy Relations

Introduction –classical sets and fuzzy sets – classical relations and fuzzy relations – membership functions –fuzzy to crisp conversion-fuzzy arithmetic- numbers-vectors-and extension principle.

UNIT-V: Fuzzy Decision Making

Classical logic and fuzzy logic –fuzzy rule based systems –fuzzy nonlinear simulation –fuzzy decision making–fuzzy control systems –fuzzy optimization –one-dimensional optimization. Neuro Fuzzy: Mathematical formulation of adaptive Neuro-fuzzy inference systems.

Books for Study:

1. Laurence Fausett, "*Fundamentals of Neural Networks-Architectures",* algorithms and applications, Pearson Education Inc., 2004.
2. Timothy J. Ross, "*Fuzzy Logic with Engg. Applications*", John Wiley and sons, 2004.

Booksfor Reference:

1. J.S.R. Jang, C.T. Sun, E. Mizutani,, "*Neuro Fuzzy and Soft Computing - A computational Approach to Learning and Machine Intelligence*", Pearson Education Inc., 2002.
2. S.Haykin,"*Neural Networks, A Comprehensive Foundation*", Pearson Edu. 2004.
3. Jacek.M.Zurada,"*Introduction to Artificial Neural Systems*",Jaico Publishing House, 2001.

Course Outcomes

Upon Completion of the course, the students will be able to:

- Learn the approaches to intelligent control, architecture for intelligent control.
- Implement machine learning through neural networks.
- Develop a Neuro fuzzy expert system.
- Use the optimization techniques to solve the real world problems.

GROUP - III

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
IV	PYTHON WITH RASPBERRY PI	CEC	6	5

Learning Objectives

- ✓ To introduce the python language to the students.
- ✓ Toenhance their problem solving abilities.
- ✓ To implement Various Embedded/IOT Applications on Raspberry Pi using Python Programming.

UNIT –I: Introduction to Python

Introduction to Python –Program Output, Input and Raw Input () Built-In Function - Comments - Operators–Variables and Assignment – Numbers – Syntax and Style and Exercises - Python Objects and Exercises – Numbers and Exercises – Sequences and Exercises – Dictionaries and Exercises.

UNIT –II: Conditionals and Loops, GUI Programming

Conditionals and Loops and Exercises – Files and Input/output and Exercises – Errors and Exceptions and Exercises – Modules and Exercises – Regular Expressions and Exercises – Network Programming and Exercises – GUI Programming with Tkinter and Exercises – Web Programming Aand Exercises.

UNIT –III: Introduction of Raspberry Pi

Introduction to The Platform RPi Documentation –The Raspberry Pi Hardware – Raspberry Pi Accessories – Linux On the Raspberry Pi – Connecting to A Network – Communicating with The RPi– Controlling The Raspberry Pi – Configuring The Raspberry Pi – Introducing Embedded Linux – Managing Linux Systems Using Git for Versions Control.

UNIT –IV: Interfacing ADC and Serial Communications

Interfacing Electronics –I²C Hardware – An I²C Test Circuit Using LinuxI²c – Tools – SPI Hardware –SPI on the RPi– SPI Application –Multiple SPI Slave Devices on the RPi - UART – Analog to Digital Conversions – Digital to Analog Conversions.

UNIT –V: Wireless Communication and Applications

Wireless Communication and Control –Raspberry Pi with A Rich User Interface –Images, Video and Audio – LED Interfacing with RPi– ADC Applications– I²C and SPI Digital to Analog Converter.

Books for Study:

1. Oreilly,WesleyJ.Chun, "*Core Python Programming*" Publisher :Pentice Hall PTR First Edi 2000.
2. Derek Molloy, "*Interfacing to the Real World with Embedded Linux*", Published by John Wiley &Sons,Inc 2016.

Books for Reference:

1. "Learn Raspberry Pi Programming with Python" by WolframDonat, Published by Apress 2016.
2. "Raspberry Pi GPU Audio Video Programming" by Jan Newmarch, Published byApress2016.

Course Outcomes

After successful completion of this course, students should be able to:

- Write their own code in python for a specific application.
- Develop application programs in Python.
- Implement applications on Raspberry Pi.
- Develop and Implement Embedded/IOT applications using Python and Raspberry Pi.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
IV	WIRELESS SENSOR NETWORKS	CEC	6	5

Learning Objectives

- ✓ To gain knowledge and understanding of wireless sensor networks.
- ✓ An overview of the unique design challenges presented by wireless sensor networks.
- ✓ To aware of the current research and development issues, and will know advanced methods for wireless sensor network development.
- ✓ To introduce students to the state of the art in wireless sensor actuator networks.

UNIT-I: Introduction and Applications of Wireless Sensor Network

Background of Sensor Network Technology – Applications of Sensor Networks – Architectural Elements – Challenges and Hurdles – Range of Applications – Home Control – Building Automation – Industrial Automation – Sensor and Robots – Highway Monitoring.

UNIT-II: Wireless sensor and Technology

Sensor Mode Technology – Hardware and Software – Sensor Taxonomy –Wireless Network Operating Environment – Wireless Network Trends – Radio Technology Principle – Available Wireless Technology – Campus Application – MAN/WAN Applications.

UNIT–III: MAC and Routing Protocols

Fundamentals of MAC protocol – MAC Protocol for Wireless Sensor Networks – Data Dissemination and Gathering – Routing Challenges and Design Issues in Wireless Sensor Networks.

UNIT –IV: Transport Protocols and Network Management

Traditional Transport Control Protocols – Design Issues – Examples – Performance of Transport Control Protocols – Network Management Requirements – Network Management Models.

UNIT–V: Operating System for Wireless Sensor Networks and Traffic Management

Operating System Design Issues – Examples of Operating System - Wireless Sensor Networks Design Issues – Performance Modeling of Wireless Sensor Networks – Basic Models - Network Models.

Books for study:

1. KazemSohraby, Daniel Minoli, TaiebZnati, "*Wireless Sensor Networks, Technology*", Protocol and Applications, Wiley, 2014.
2. Feng Zhao, Leonidas Guibas, "*Wireless Sensor Networks*", Elsevier, First Indian Reprint, 2005.

Books for Reference:

1. Anantharam Swami, Qing Zhao, Yao-Win Hung, Lang Long,"*Wireless Sensor Networks, Signal Processing and Communication Perspective*", Wiley, India, 2009.
2. JaganathanSarangapani,WirelessAdHoc,"*Wireless SensorNetworks,Protocols, Performance and Control*", CRC press, First Indian Reprint,2009.

Course Outcomes

At the end of this course, students will be able to:

- Define wireless sensor networks.
- Describe the area of wireless sensor networks.
- Describe the current research and development issues in wireless sensor networks.
- Demonstrate deeper methodological knowledge in wireless sensor networks.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
IV	ADVANCED DIGITAL IMAGE PROCESSING	CEC	6	5

Learning Objectives

- ✓ To develop an overview in the field of image processing.
- ✓ To understand and implement the fundamental algorithms of image processing.
- ✓ To gain experience in applying image processing algorithms to real-time problems.

UNIT- I: Basics of Image Processing

Introduction –Fundamental Steps in DIP-Elements of Visual Perception-Image Sensing and Acquisition-Image Sampling and Quantization-Imaging Geometry-Discrete Image Mathematical Characterization-Basic Relationship between Pixels. Basic Gray Level Transformations-Histogram Processing-Spatial Correlation and Convolution-Smoothing Spatial Filters-Sharpening Spatial Filters.

UNIT -II: Image Representation in Transforms Domain

Fast Fourier transform-inverse FFT-discrete Fourier transform-discrete cosine Transform-Fourier-mellin transform-karhunen-loeve transform-SVD Multi-resolution analysis, scaling functions-MRA refinement equation-wavelet series expansion-discrete wavelet transform-2D wavelet transforms.

UNIT- III: Image Enhancement in Frequency domain and Restoration

Smoothing frequency domain Filters-Sharpening frequency domain filters-homomorphic filtering-basic framework-image deformation and geometric transformations-restoration techniques-noise characterization-noise restoration filters-adaptive-linear-position invariant degradations

UNIT -IV: Image Compression

Overview of image compression techniques-wave based image compression-lossy and lossless compression-quantization-entropy encoding-JPEG and MPEG standards.

UNIT- V: Image Segmentation

Local feature extraction techniques Detection of discontinuities-edge linking and boundary detection-thresholding-edge based segmentation-matching morphological segmentation-watershed algorithm.

Books for Study:

1. Rafael C. Gonzalez and Richard E. Woods, "*Digital Image Processing*", 3rd Edition, Pearson Education,2012.
2. Nasser Kehtarnavaz, Mark Noel Gamadia, "*Real-time image and video processing: from research to reality*", Morgan Claypool publishers, 2006.

Books for References:

1. S. Jayarman, S. Esakkirajan, T. Veerakumar, "*Digital Image Processing*", Tata McGraw Hill,2010.
2. Anil K. Jain, "*Fundamentals of Digital Image Processing*", Pearson Education,2003.
3. Milan Sonka, Vaclav Hlavac and Roger Boyle, "*Image Processing, Analysis and Machine Vision*", 2nd Edition, Thomson,2007.

Course Outcomes

The students will be able to:

- Understand image formation and the role of human visual system plays in perception of gray.
- Apply the appropriate image processing algorithm to process, enhance and either extract or impart information from the image.
- Learn the signal processing algorithms and techniques in image enhancement and image restoration.

GROUP - IV

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
IV	INTERNET OF THINGS	CEC	6	5

Learning Objectives

- ✓ To Study about Internet of Thingstechnologies and its role in real timeapplications.
- ✓ To familiarize the accessories and communication techniques forIOT.
- ✓ To familiarize the different platforms and Attributes forIOT.

UNIT-I: Introduction to Internetof Things

Overview, Technologydrivers, Businessdrivers, Typical IoT applications, Trends andimplications.

UNIT-II: IOTArchitecture

Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture,IoT standards, Cloud computing for IoT,Bluetooth, Bluetooth Low Energy, beacons.

UNIT-III: Protocols and Wireless TechnologyforIOT

Protocols: NFC, RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe Wired vs. Wireless communication,GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems.

UNIT-IV: Data Analyticsfor IOT

Services/Attributes: Big-Data Analytics and Visualization,Dependability,Security,Maintainability.

Data analytics for IoT: A framework for data-driven decision making, Descriptive, Predictive and Prescriptive Analytics, Business Intelligence and Artificial Intelligence Importance of impact and open innovation in data-driven decisionmaking.

UNIT-V: Case Studies

Home Automation, smart cities, Smart Grid, Electric vehicle charging, Environment, Agriculture, Productivity Applications.

Books for Study:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach "Internet of Things",Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi " The Internet of Things",Wiley,2016.
3. Samuel Greengard, "The Internet of Things", The MIT press,2015.

Books for Reference:

1. Adrian McEwen and Hakim Cassimally"Designing the Internet of Things"Wiley,2014.
2. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons,2014.
3. OvidiuVermesan and Peter Friess (Editors), "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series in Communication, 2013.

Course Outcomes

At the end of the course the student will be able to

- Students will develop more understanding on the concepts of IOT and its present developments.
- Study about different IOTtechnologies.
- Acquire knowledge about different platforms and Infrastructure forIOT.
- Learn the art of implementing IOT for smart applications andcontrol.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
IV	ADVANCED ARM MICROCONTROLLER	CEC	6	5

Learning Objectives

- ✓ To learn the advanced architecture of ARM processors.
- ✓ To know the timer function and counter operation of ARM processors.
- ✓ To know the fundamentals and interfacing devices with parallel and serial ports.

UNIT-I: STM ARM I/O Programming

STM32 Microcontroller – GPIO Programming and Interfacing – Seven Segments LED Interfacing and Programming – I/O Port Programming with Assembly Language – LCD Interfacing.

UNIT–II: Timer and Serial Port Programming

STM Arm Timer Programming – System Tick Timer – Timer and Delay Generation in STM32F4xx – Compare Register and Waveform Output – Using Timer/Counter for Input Capture – Pulse Counter Programming.

UNIT–III: Interrupt and Exception Programming

Interrupts and Exception in Arm Cortex-M – Interrupt Programming – USART Serial Port Interrupt Programming – SysTick Programming and Interrupts – Timer Interrupt Programming – Interrupt Priority Programming in STM32 ARM.

UNIT-IV: ADC and Sensor Interfacing

ADC Characteristics – ADC Programming with STM32 Arm – Sensor Interfacing and Signal Conditioning.

UNIT-V: SPI, I²Cand UART Protocol

UART Serial Port Programming – SPI Protocol – I²C Bus Protocol – DS1337 RTC Interfacing and Programming – Stepper Motor Interfacing.

Book for Study:

1. Muhammad Ali Mazidi and Shujen Chen,*"STM32 Arm Programming for Embedded Systems"*,Volume6,2018.

Books for Reference:

1. Donald Norris,*"Programming with Stm32: Getting Started with the Nucleo Board and C/C++",*2018.
2. https://www.st.com/en/microcontrollers/stm32f401.html?querycriteria=productId=LN1810.
3. https://www.st.com/content/ccc/resource/technical/document/reference_manual/5d/b1/ef/b2/a1/66/40/80/DM00096844.pdf/files/DM00096844.pdf/jcr:content/translations/en.DM00096844.

Course Outcomes

At the end of this course, students will be able to:

- Understand the architecture and programming of ARM processors.
- Develop programming to real world applications.
- Acquire knowledge to get data from the external devices for data processing.
- Develop their employability and entrepreneurship skills.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
IV	NETWORK ON CHIP	CEC	6	5

Learning Objectives

- ✓ To understand the fundamentals of system on chip.
- ✓ To impart knowledge about the architecture design of Network on chip.
- ✓ To know the router architectures in 3D NOC.

UNIT– I: Introduction

System-On-Chip Integration and Its Challenges – SoC to Network-On-Chip: A Paradigm Shift Research Issues in NoC Development –Existing NoC Examples. Network Topologies – Switching Techniques – Routing Strategies – Flow Control Protocol – Quality-of-Service Support – NI Module.

UNIT-II: Architecture Design of Network-On-Chip

Switching Techniques and Packet Format – Asynchronous FIFO Design – GALS Style of Communication – Wormhole Router Architecture Design – VC Router Architecture Design – Adaptive Router Architecture Design.

UNIT–III: Application Mapping on Network-On-Chip

Mapping Problem – ILP Formulation – Constructive Heuristics for Application Mapping – Constructive Heuristics with Iterative Improvement – Mapping Using Discrete PSO. Standard Low-Power Methods for NoC Routers – Standard Low-Power Methods for NoC Links – System-Level Power Reduction.

UNIT-IV: ASNoC Synthesis

ASNoC Synthesis Problem – Literature Survey – System-Level Floor planning –Custom Interconnection Topology and Route Generation – ASNoC Synthesis with Flexible Router Placement.

UNIT-V: Reconfigurable Network-On-Chip Design:

Literature Review – Local Reconfiguration Approach – Topology Reconfiguration– Link Reconfiguration.3-D Integration: Pros and Cons – Design and Evaluation of 3-D NoC Architecture.

Book for Study:

1. SantanuKundu, Santanu Chattopadhyay *"Network – on – Chip"* by Taylor and Francis Group LCC, 2015.

Books for Reference:

1. ChrysostomosNicopoulos, Vijaykrishnan Narayanan, Chita R.Das,*"Networks-on-Chip Architectures"*, AHolistic Design Exploration, Springer, 2009.
2. Jose Flich ,DavideBertozzi, *"Designing Network On-Chip Architectures in the Nanoscale Era"*, Publisher: Chapman and Hall/CRC; 1 edition (December 18,2010).

Course Outcomes

At the end of the course, student will able to:

- Understand the need for 3D NOC.
- The concepts used in testing and reduction of power in NOC.
- Ability to learn the architecture and working of routers in 3D NOC.

OPEN ELECTIVE COURSE

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
II	THE 8051 MICROCONTROLLER ARCHITECTURE AND PROGRAMMING	OEC	4	4

Learning Objectives

- ✓ Learn the architecture of 8051 microcontrollers and their internal organization, interfacing an external device with the microcontrollers.
- ✓ To know how to interface the I/O port with the external peripherals.
- ✓ To understand the fundamental concepts of communication with the external world.

UNIT-I: 8051 Microcontroller Architecture

Microcontroller Versus General Purpose Microcontroller - Microcontroller for Embedded Systems – Criteria for Choosing a Microcontroller – Overview of the 8051 – Internal Architecture – Registers – Internal RAM – 8051 Register Banks and Stack – Program Counter – Addressing Modes.

UNIT-II: Instruction Set

Instruction Set – Data Transfer Instructions – Arithmetic – Logical – Boolean Variables Manipulation – Program Branching – Simple Programs: Addition – Subtraction – MultiplicationDivision – Direct Bank Register Addressing – Indirect register bank addressing – RAM direct addressing – DPTR pointer register and external memory – stack operation – subroutines.

UNIT-III: I/O Port Programming

I/O Port Pins and their Functions – I/O Bit Manipulation Programs – Polling a Button and Turn on a LED – Button Debouncing –ADC Converter – Stepper Motor- LCD Interfacing – DAC Interfacing – Temperature Measurement.

UNIT-IV: Timers Programming

Programming 8051 Timers – TMOD Register – TCON Register – Mode 1 Programming – Mode 2 Programming – Program for Generating Square Wave Generator using Mode 1 and Mode 2 – Counter Programming – Pulse Measurement –.

UNIT-V: Serial Port and Interrupt Programming

Basics of Serial Communications – Serial Port Programming – SBUF Register – SCON Register – Simple Program: Transfer and Receive Data Serially – 8051 Interrupts – IE Registers – Interrupt Priority – Simple Program Using Interrupts.

Books for Study:

1. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. Mckinlay,"*8051 Microcontroller and Embedded Systems using Assembly and C*", Pearson Education 2007.
2. MykePredko, "*Programming and customizing the 8051 microcontroller*", Tata McGraw Hill 2001.
3. Michael J. Pont," Embedded *C*", Pearson Education, First Edition,2013.

Books for Reference:

1. K.UmaRao, AndhePallavi, "*The 8051 Microcontrollers Architecture, Programming and Applications*", Pearson, Second impression 2011.
2. Kenneth.J.Ayala, "*The 8051 Microcontroller*", Thomson, Third Edition 2007.
3. ZdraUkoKarakehayou, KnudSmedChristengen," *Embedded System Design with 8051 Microcontroller*", Marcel Dekker Inc, First Edition, 2010.

Course Outcomes

After the completion of this course the student will be able to:

- Understand the basic working of 8051, which is the basic of all microcontrollers.
- Know the working nature of different peripherals, and programming techniques.

- Implementation of the programming sequence using Keil C and loading the same to some application oriented boards.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
II	ADVANCED MICROCONTROLLER	OEC	4	4

Learning Objectives

- ✓ To emphasize controller architecture, instruction set, memory organization and embedded C programming.
- ✓ To interfacing the peripherals such as general purpose input/output, timers, interrupts, and serial communication.
- ✓ The course is accompanying by laboratory experiments directly linked to the lecture topics for hands-on learning of the material.
- ✓ To get familiar with the Silicon Laboratories IDE and learn how to use it.

UNIT-I: Introduction to Silicon Labs' C8051F020
Introduction- CIP-51 - C8051F020 System Overview - Memory Organization - Memory Organization - I/O Port and Crossbar - Instruction Set.

UNIT-II: ASM Directives
Address Control - Symbol Definition - Memory Initialization/Reservation - Segment Control - Oscillator Programming Registers - Watchdog Timer - Digital Crossbar - GPIO -Crossbar and GPIO SFRs Ports 4.

UNIT-III: C8051F020 C Programming and Timer Operation
Register Definition-Initialization and Startup Code - Programming Memory Models - Function - Interrupt Functions - Timers 0 and 1 Operation Mode – Timers 2, 3 and 4 Operation Mode.

UNIT-IV: ADC and DAC, Serial Communication, Interrupts
12-bit ADC - 8-bit ADC -12-bit DACs - UART0 and UART1- Operation Modes – Interrupts.

UNIT –V: Applications
Blinking of LED Using Software Delays - Blinking of LED Using a Timer - Programming the LCD – Reading Analog Signals- Digital to Analog Convertor-Blinking LED at Different Frequencies.

Book for Study:

1.Sen Gupta, Subhas Chandraby ,"*Embedded Microcontroller Interfacing*"Gourab Mukhopadhyay Scientific Publishing Services Pvt. Ltd., Chennai, India**,** 2010.

Books for Reference:

1. Michael J. Pont,"*Embedded C",* Pearson Education, First Edition,2013.
2. http://www.keil.com/dd/docs/datashts/silabs/c8051f02x.pdf
3. https://www.silabs.com/documents/public/user-guides/C8051F02x-DK.pdf

Course Outcomes

At the end of this course, students be able to:

- Provide an overview of the microcontroller architecture and programming.
- Use an integrated development environment to program.
- Understand and use analog to digital converters, digital to analog converters and other peripherals.

SEM	EMBEDDED SYSTEMS	CT	HOURS	CREDITS
II	ONLINE COURSE	OEC	4	4

Online Course (MOOC/NPTEL/SWAYAM/e-pathshala)

An Online Course is aimed at unlimited participation and open access via the web. Online course is a model for delivering learning content online to any person who takes a course, with no limit on attendance.

A student shall undergo anonline course for award of the degree besides other requirements. A student is offered this Online Course at the beginning of theirII Semesterof study and the course has to be completed at the end of II Semester.

If the student fails to complete the course by the end of II Semester, it shall be treated as a backlog and needs to be completed before completion of the program for the award of the degree. A student has a choice of registering for only one online courses with the recommendation of Course coordinator.

The student shall undergo online course without disturbing the normal schedule of regular class work. One faculty member assigned by the Coordinator shall be responsible for the periodic monitoring of the course implementation.

If any student wants to change the online course already registered, he will be given choice to register a new online course in II Semester only. Finally, the performance of the student in the course will be evaluated as stipulated by the course provider.

A certificate will be issued on successful completion of the course by the course provider. The performance in the online course will not be considered for the calculation CGPA of the student. The online course will be listed in the grade sheets of the student.