



VIT[®]

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

School of Electronics Engineering

M. Tech. – Embedded Systems

Curriculum and Syllabus

2022-23

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

To be a leader by imparting in-depth knowledge in Electronics Engineering, nurturing engineers, technologists and researchers of highest competence, who would engage in sustainable development to cater the global needs of industry and society.

MISSION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

- Create and maintain an environment to excel in teaching, learning and applied research in the fields of electronics, communication engineering and allied disciplines which pioneer for sustainable growth.
- Equip our students with necessary knowledge and skills which enable them to be lifelong learners to solve practical problems and to improve the quality of human life

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The graduates of the programme will be able to

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems
2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry
3. Graduates will function in their profession with social awareness and responsibility
4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country
5. Graduates will be successful in pursuing higher studies in engineering or management
6. Graduates will pursue career paths in teaching or research

PROGRAMME OUTCOMES (POs)

On completion of the Programme the students will have the

PO_01: Having an ability to apply mathematics and science in engineering applications.

PO_02: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_03: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_04: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_05: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_06: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_07: Having a clear understanding of professional and ethical responsibility

PO_08: Having a good cognitive load management skills related to project management and finance

Programme Specific Outcomes (PSOs)

On completion of M. Tech. Embedded Systems, graduates will be able to

PSO1. Apply the advanced concepts of Embedded System Design with real-time constraints using advanced Microcontrollers and FPGA based systems.

PSO2. Use the cutting-edge technologies in both hardware and software, to solve real-world multi-disciplinary problems and arrive at a viable solution.

PSO3. Independently carry out research on diverse Embedded System strategies to address practical problems and present a substantial technical report.

M. Tech - Embedded Systems

CURRICULUM

[Curriculum for Applied Learning (CAL)]

S. No	Category	Credits
1	Discipline Core	24
2	Skill Enhancement	05
3	Discipline Elective	12
4	Projects and Internship	26
5	Open Elective	03
Total Credits		70

Master of Technology in Embedded Systems
School of Electronics Engineering

Programme Credit Structure		Credits						
Discipline Core Courses		24	MEDS603L	Design and Analysis of Algorithms	3	0	0	3
Skill Enhancement Courses		05	MEDS604L	Embedded System design using FPGA	2	0	0	2
Discipline Elective Courses		12	MEDS604P	Embedded System design using FPGA Lab	0	0	2	1
Open Elective Courses		03	MEDS605L	Hardware Software Co-design	2	0	0	2
Project/ Internship		26	MEDS606L	Modern Automotive Electronics Systems	3	0	0	3
Total Graded Credit Requirement		70	MEDS607L	Advanced Processors and its Applications	2	0	0	2
Discipline Core Courses		24	MEDS607P	Advanced Processors and its Applications Lab	0	0	2	1
		L T P C	MEDS608L	Intelligent IoT System Design and Architecture	2	0	0	2
MEDS501L	Embedded System Design	3	0	0	3			
MEDS502L	Microcontroller Architecture and Organization	3	0	0	3			
MEDS502P	Microcontroller Architecture and Organization Lab	0	0	2	1			
MEDS503L	Embedded Programming	3	0	0	3			
MEDS503P	Embedded Programming Lab	0	0	2	1			
MEDS504L	In Vehicle Networking	3	0	0	3			
MEDS505L	Real Time Operating System	3	0	0	3			
MEDS505P	Real Time Operating System Lab	0	0	2	1			
MEDS506L	Wireless and Mobile Communication	3	0	0	3			
MEDS507L	Electronic Hardware System Design	2	0	0	2			
MEDS507P	Electronic Hardware System Design Lab	0	0	2	1			
Skill Enhancement Courses		05	MEDS608P	Intelligent IoT System Design and Architecture Lab	0	0	2	1
MENG501P	Technical Report Writing	0	0	4	2			
MSTS501P	Qualitative Skills Practice	0	0	3	1.5			
MSTS502P	Quantitative Skills Practice	0	0	3	1.5			
Discipline Elective Courses		12	MEDS609L	Fault Tolerance and Dependable Systems	3	0	0	3
MEDS601L	Electromagnetic Interference and Compatibility in ESD	3	0	0	3			
MEDS602L	Advanced Digital Image Processing	3	0	0	3			
Open Elective Courses		03	MEDS610L	Advanced Machine Learning and Deep Learning	2	0	0	2
			MEDS610P	Advanced Machine Learning and Deep Learning Lab	0	0	2	1
			MEDS611L	Parallel Processing and Computing	3	0	0	3
			MEDS612L	Advanced Embedded Programming	3	0	0	3
			MAME602L	AUTOSAR and ISO Standards for Automotive Systems	2	0	0	2
Project and Internship		26						
			MEDS696J	Study Oriented Project	02			
			MEDS697J	Design Project	02			
			MEDS698J	Internship I/ Dissertation I	10			
			MEDS699J	Internship II/ Dissertation II	12			

Course Code	Course Title	L	T	P	C
MEDS501L	Embedded System Design	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course aimed at					
<ol style="list-style-type: none"> 1. Ability to understand comprehensively the technologies and techniques underlying in building an embedded solution to a wearable, mobile and portable system. 2. Analyze UML diagrams and advanced Modelling schemes for different use cases. 3. Understand the building process of embedded systems 					
Course Outcome					
The students will be able to					
<ol style="list-style-type: none"> 1. Define an embedded system and compare with general purpose system. 2. Appreciate the methods adapted for the development of a typical embedded system. 3. Get introduced to RTOS and related mechanisms. 4. Classify types of processors and memory architecture 5. Differentiate the features of components and networks in embedded systems 6. Develop real-time working prototypes of different small-scale and medium-scale embedded Systems. 7. Apprehend the various concepts in Multi-Tasking 					
Module:1	Introduction to Embedded System	5 hours			
Embedded system processor, hardware unit, software embedded into a system, Example of an embedded system, Embedded Design life cycle, Layers of Embedded Systems.					
Module:2	Embedded System Design Methodologies	5 hours			
Embedded System modelling [FSM, SysML, MARTE], UML as Design tool, UML notation, Requirement Analysis and Use case Modelling, Design Examples					
Module:3	Building Process For Embedded Systems	4 hours			
Preprocessing, Compiling, Cross Compiling, Linking, Locating, Compiler Driver, Linker Map Files, Linker Scripts and scatter loading, Loading on the target, Embedded File System.					
Module:4	System design using general purpose processor	7 hours			
Microcontroller architectures (RISC, CISC), Embedded Memory, Strategic selection of processor and memory, Memory Devices and their Characteristics, Cache Memory and Various mapping techniques, DMA.					
Module:5	Component Interfacing & Networks	9 hours			
Memory Interfacing, I/O Device Interfacing, Interrupt Controllers, Networks for Embedded systems- USB, PCI,PCI Express, UART, SPI, I2C, CAN, Wireless Applications - Bluetooth, Zigbee,Wi-Fi.,6LoWPAN , Evolution of Internet of things (IoT).					
Module:6	Operating Systems	7 hours			
Introduction to Operating Systems, Basic Features & Functions of an Operating System, Kernel & its Features [polled loop system, interrupt driven system, multi rate system], Processes/Task and its states, Process/Task Control Block, Threads, Scheduler, Dispatcher.					
Module:7	Multi Tasking	6 hours			
Context Switching , Scheduling and various Scheduling algorithms, Inter-process Communication (Shared Memory, Mail Box, Message Queue), Inter Task Synchronization (Semaphore, Mutex), Dead Lock, Priority Inversion (bounded and unbounded), Priority Ceiling Protocol & Priority Inheritance Protocol					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	

Text Book(s)			
1.	Raj Kamal, "Embedded systems Architecture, Programming and Design", Tata McGraw- Hill, 2016.		
2.	Wayne Wolf "Computers as components: Principles of Embedded Computing System Design", The Morgan Kaufmann Series in Computer Architecture and Design, 2013.		
Reference Books			
1.	Lyla B. Das," Embedded Systems an Integrated Approach", Pearson Education, 2013.		
2.	Shibu K V," Introduction to Embedded Systems", McGraw Hill Education(India) Private Limited, 2014		
3.	Sriram V Iyer, Pankaj Gupta " Embedded Real Time Systems Programming", Tata McGraw- Hill, 2012		
4.	Steve Heath, "Embedded Systems Design", EDN Series, 2013.		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS502L	Microcontroller Architecture and Organization	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course aimed at					
<ol style="list-style-type: none"> 1. Describing the architecture of 8051 microcontroller and ARM processor 2. Teaching the instruction set of 8051 and ARM microcontroller to efficient programs 3. Designing system in block level using microcontroller, memory devices, buses and other peripheral devices 4. Solving real life problem using microcontroller-based systems 					
Course Outcome					
At the end of the course, the students will be able to					
<ol style="list-style-type: none"> 1. Describe the architectures of processors 2. Develop Assembly program applying Digital logic and mathematics using 8051 3. Develop Assembly Language Program for ARM 4. Develop ALP with minimum instructions and memory. 5. Analyze and evaluate the given program in terms of code size and computational time 6. Design Microcontroller based system within realistic constraint like user specification, availability of components etc 7. Solve real life problem and construct a complete system as a solution 					
Module:1	Introduction to Microcontrollers	5 hours			
Microprocessors Vs Microcontrollers; Classification – bits, memory architecture, ISA; Little Endian Vs Big Endian.					
Module:2	8051 Microcontroller	6 hours			
Architecture – Timers, Interrupts, Register Architecture (banks), PSW register, Memory architecture; Instruction set.					
Module:3	8051 Programming and Interfaces	8 hours			
Programming in C & Assembly for – Interrupts, Timers and Interfaces – PORTS, LED, ADC, SENSORS, LCD, DAC, Serial Communication					
Module:4	ARM Architecture	4 hours			
ARM Design Philosophy; Overview of ARM architecture; States [ARM, Thumb, Jazelle]; Registers, Modes; Conditional Execution; Pipelining; Vector Tables; Exception handling.					
Module:5	ARM Instruction Set	6 hours			
ARM Instruction- data processing instructions, branch instructions, load store instructions, SWI instruction, Loading instructions, conditional Execution, Assembly Programming.					
Module:6	Thumb Instruction Set	6 hours			
Thumb Instruction-Thumb Registers, ARM Thumb interworking, branch instruction, data processing instruction, single/multiple load store instruction, Stack instruction, SWI instruction, Assembly Programming.					
Module:7	ARM Core based Microcontroller	8 hours			
Architecture of LPC214X, Memory Addressing, IO ports, Timers/counter, Watch Dog Timer, PWM, ADC/DAC, UART, Interrupts, Displays, C programming.					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	
Text Book(s)					
1.	Andrew N.Sloss, Dominic Symes, Chris Wright, ARM Developer's Guide, 2010, 1 st Edition, Elsevier, United States				

2.	Kenneth Ayala, The 8051 Microcontroller & Embedded Systems Using Assembly and C, 2010, 1st edition, Cengage Learning, United States		
Reference Books			
1.	Steve Furber ARM System on Chip Architecture, 2010, 2 nd Edition, Addison Wesley, United States		
2.	Technical Reference Manual CORTEX M-3, ARM, 2010, United States		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS502P	Microcontroller Architecture and Organization Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at					
<ol style="list-style-type: none"> 1. Describing the architecture of 8051 microcontroller and ARM processor 2. Teaching the instruction set of 8051 and ARM microcontroller to efficient programs 3. Designing system in block level using microcontroller, memory devices, buses and other peripheral devices 4. Solving real life problem using microcontroller-based systems 					
Course Outcome					
At the end of the course the students will be able to					
<ol style="list-style-type: none"> 1. Develop Assembly program applying Digital logic and mathematics using 8051 2. Develop Assembly Language Program for ARM and ARM peripherals 3. Develop ALP with minimum instructions and memory. 4. Analyze and evaluate the given program in terms of code size and computational time 					
Indicative Experiments					
1	Task-1: Calculator Application Sub task 1: Make the LCD interfaced to 8051 Sub task 2: Get input from switch which is interfaced to 8051 and display it on LCD Sub task 3: Based on switch input, perform basic operation of a Calculator	7 hours			
2	Task-2: Speed control of motor Sub task-1: Use timer and generate an exact time delay for T _{ON} and TOFF Sub task-2: Use timer interrupt in generating the waveform Sub task-3: Controlling speed of a DC motor using Timer	7 hours			
3	Task-3: Microcontroller based application Sub task-1: Interface Zigbee with 8051 Sub Task-2: Interface keypad with 8051 Sub Task-3: Interface GSM with 8051 Sub task-4: Based on KEY pressed in keypad, transmit the key info Via Zigbee and make a motor to rotate, which is interfaced with 8051. Using GSM module send the status of motor [run/stop] to the user	8 hours			
4	Task-4: Sensor interfacing with ARM LPC2148 Sub Task-1: Interface IR with LPC2148 Sub Task-2: Interface temperature sensor with LPC2148 Sub Task-3: Interface Bluetooth with LPC2148 Sub Task-4: Transmit the IR detail and sensor data to another LPC2148 via Bluetooth	8 hours			
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MEDS503L	Embedded Programming	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed					
<ol style="list-style-type: none"> 1. To acquaint students with fundamentals of C 2. To familiarize the students with data structures 3. To introduce the students with SHELL programming and Linux 4. To Implement the Device drivers in LINUX environment 					
Course Outcome					
At the end of the course the students will be able to					
<ol style="list-style-type: none"> 1. Comprehend the fundamentals of C 2. Comprehend the Data structures 3. Comprehend the basics of Linux 4. Showcase the skill, knowledge and ability of SHELL programming. 5. Exhibit the working knowledge of basic Embedded Linux 6. Comprehend the concepts of Kernel module Programming 7. Write Device driver programs 8. Have hands on experience in using state-of- art hardware and software tools 					
Module:1	C Language	7 hours			
Basic concepts of C, Embedded C Vs C, Embedded programming aspects with respect to firmware and OS Functions, Arrays, pointers, structures and Inputs/Outputs.					
Module:2	Data structures of kernel programming	6 hours			
Linked list, Single linked list, Double linked list and Queues.					
Module:3	Linux	6 hours			
Command prompt, X windows basics, Navigating file system, finding files, working with folders, reading files text editing in Linux, Compression and archiving tools, Basic shell commands, File Management, I/O Handling, File Locking.					
Module:4	Shell Programming	7 hours			
Processes, giving more than one command at a time, prioritizing and killing processes, Scheduling Commands, pipes and redirection, regular expression, pattern matching, Scripting using for while, if and other commands.					
Module:5	Embedded Linux	6 hours			
Linux Basics, Booting process, make files , using SD card and reader to transfer programs, Introduction to LINUX system calls, API's, device drivers, compiling and installing a device driver.					
Module:6	Kernel Module Programming	6 hours			
Compiling kernel, Configuring Kernel and compilation, Kernel code, browsers.-Static linking, dynamic linking of modules, User space, kernel space concepts, Writing simple modules – Writing, Make-files for modules.					
Module:7	Device Driver concepts	5 hours			
Driver concepts, Block & character driver distinction, Low level drivers, OS drivers etc, Writing character drivers, Device major, minor number.					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	
Text Book(s)					
1.	Neil Mathew, Richard stones, Beginning Linux Programming, 2012 reprint, Wrox – Wiley Publishing, USA.				

2.	Eric Foster Johnson, John C. Welch, Micah Anderson, Beginning shell scripting, 2012, reprint, Wrox – Wiley Publishing, USA		
Reference Books			
1.	Derek Molloy, Exploring Beagle Bone: Tools and Techniques for Building with Embedded Linux, 2015, 1 st Edition, Wiley Publications, USA		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS503P	Embedded Programming Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed					
<ol style="list-style-type: none"> To acquaint students with fundamentals of C To familiarize the students with data structures To introduce the students with SHELL programming and Linux To Implement the Device drivers in LINUX environment 					
Course Outcome					
At the end of the course the students will be able to					
<ol style="list-style-type: none"> Comprehend the fundamentals of C Comprehend the Data structures Comprehend the basics of Linux Showcase the skill, knowledge and ability of SHELL programming. Exhibit the working knowledge of basic Embedded Linux Comprehend the concepts of Kernel module Programming Write Device driver programs Have hands on experience in using state-of- art hardware and software tools 					
Indicative Experiments					
1.	Task1: C programming <ul style="list-style-type: none"> Implement a binary tree sorting Implement a dice throw game Implement a command line argument based application of automation	6 hours			
2.	Task2: Implementation of data structure for an application Write a SortedMerge() function that takes two lists, each of which is sorted in increasing order, and merges the two together into one list which is in increasing order. SortedMerge() should return the new list. The new list should be made by splicing together the nodes of the first two lists.	6 hours			
3.	Task3: Shell Programming Development of inventory management system using Shell scripting with the following features <ul style="list-style-type: none"> User may add/update/delete inventory. User may add/update inventory details. Details include cost, quantity and description. Includes forms for inventory inwards and outwards.	6 hours			
4.	Task4: Build process for an embedded board Build a kernel for a Beagle Bone Black (BBB) board and board bring up, kernel module program on an embedded board	6 hours			
5.	Task5: Device driver programming –Implementation of Device Driver	6 hours			
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		28-07-2022			
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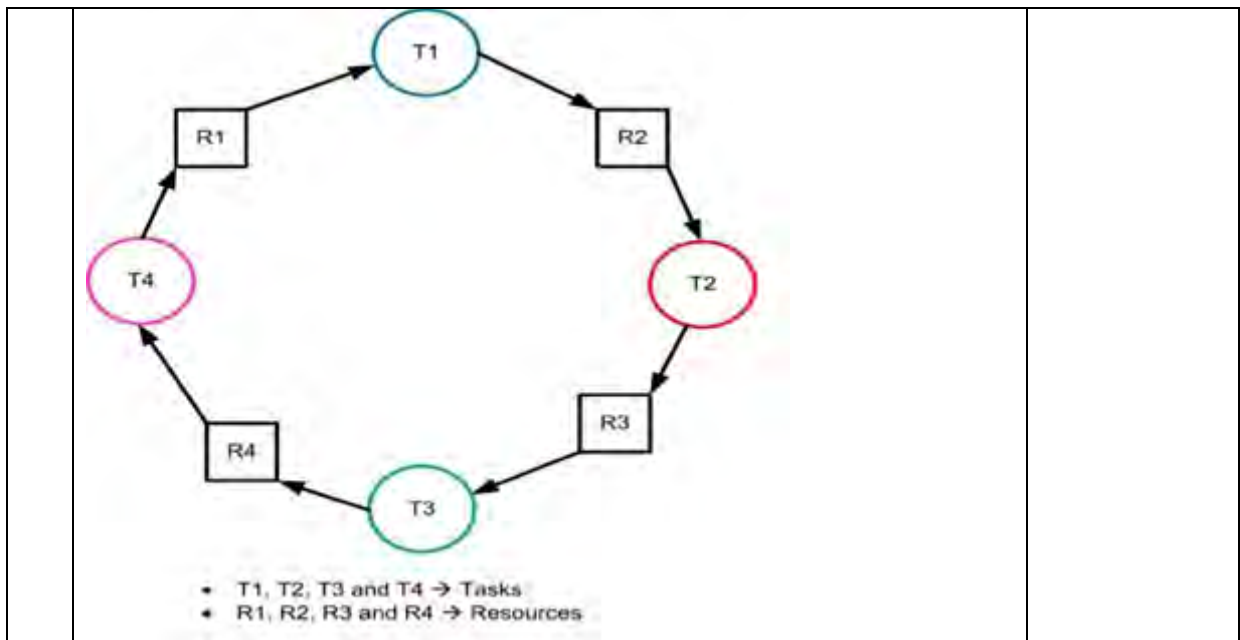
Course Code	Course Title	L	T	P	C
MEDS504L	In Vehicle Networking	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course aimed at					
<ol style="list-style-type: none"> 1. Providing students a working knowledge of in-vehicle network systems 2. Giving an exposure to aspects of design, development, application and performance issues associated with in vehicle networking systems. 3. Illustrating concepts of sensor data capture, storage and exchange of data to access remote services 					
Course Outcome					
The students will be able to					
<ol style="list-style-type: none"> 1. Know the need for In Vehicle Networking and the basics of data communication and networking concepts. 2. Comprehend protocols like CAN used in automotive applications. 3. Have an overview of the CAN higher layer protocols like CAN open, Device Net, TTCAN and SAE J1939. 4. Understand the working mechanism of LIN protocol. 5. Get an overview of MOST protocol used in automotive for multimedia applications. 6. Comprehend protocols like FlexRay used in automotive for fault tolerant applications. 7. Comprehend the general protocols and their usage in automotive sector 					
Module:1	Concepts of In-vehicle networking	6 hours			
Overview of Data communication and networking–need for In-Vehicle networking–layers of OSI reference model–multiplexing and de-multiplexing concepts–vehicle buses.					
Module:2	Networks and protocols	8 hours			
CAN protocol: principles of data exchange–real time data transmission–message frame formats, bit encoding–bit-timing and synchronization–data rate and bus length–network topology–bus access– physical layer standards.					
Module:3	CAN higher layer protocol	6 hours			
Introduction to CAN open –Device net–TTCAN–SAEJ1939–overview of CAN open and applications in transportation electronics–CAN open standards).					
Module:4	LIN protocol	5 hours			
LIN standard overview – applications – LIN communication concept message frame–development flow.					
Module:5	MOST	5 hours			
MOST overview–data rates–data types–topology –application areas.					
Module:6	FlexRay	6 hours			
Flex Ray introduction–network topology–ECU sand bus interfaces–controller host interface and protocol operation controls–media access control and frame and symbol processing–coding/decoding unit–Flex Ray scheduling–message processing– wakeup/startup–applications.					
Module:7	General purpose protocols	7 hours			
GSM- WiFi – Bluetooth and NFC Implementation –Ethernet, TCP, UDP, IP.					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	
Text Book(s)					
1.	Dominique Paret, Multiplexed Networks for Embedded Systems CAN, LIN, FlexRay, Safety-Wire, 2014, 1 st edition, Wiley, United States.				
Reference Books					

1.	Chung Ming Huang, YuhShyan Chen, Telematics Communication Technologies and Vehicular Networks: Wireless Architectures and Application, 2010, 1 st edition, Information Science Reference, United States.		
2.	Ronald K Jurgen, Distributed Automotive Embedded Systems, 2010, 4 th Edition, SAE International, United States.		
3.	Richard Zurawski, Industrial Communication Technology Handbook, 2015, 2 nd Edition, CRC press, United States.		
4.	KonradReif, Automotive Mechatronics: Automotive Networking, Driving Stability Systems Electronics, 2015, 2 nd Edition, Springer, United States.		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS505L	Real Time Operating System	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at					
<ol style="list-style-type: none"> 1. Introducing the students about Operating Systems and acquainting students to Real Time Operating Systems 2. Teaching the students about Task Management and Enabling students to understand RTOS Scheduling 3. Introducing the students about interprocess communication and Memory Management 					
Course Outcome					
At the end of the course the will should be able to					
<ol style="list-style-type: none"> 1. Comprehend the basic components of an operating system 2. Learn about the basics of real-time concepts 3. Acquire knowledge about task management 4. Acquaint with RTOS scheduling 5. Learn about IPC synchronization 6. Learn about IPC data exchange 7. Perform memory management in RTOS 8. Apply the knowledge for developing practical applications of modern real-time systems. 					
Module:1	Introduction to Operating Systems	6 hours			
Layers of Operating Systems, Operating systems functions, System Boot up - BIOS & Boot Process, Kernel – Monolithic and Microkernel					
Module:2	Real Time Operating Systems	7 hours			
Tradeoffs for RTOS, POSIX					
Module:3	Task Management	7 hours			
Process and Threads, Process Control Block, Process Attributes, POSIX Threads					
Module:4	RTOS Scheduling	7 hours			
Priority based scheduling, Rate-Monotonic scheduling, Earliest Deadline first scheduling, Linux RT scheduler.					
Module:5	IPC - Synchronization	7 hours			
IPC, Race conditions and critical sections, Signals, Atomic operations, Semaphore, Mutex, Spinlock, Priority Inversion and Priority ceiling.					
Module:6	IPC – Data Exchange	7 hours			
Shared memory, FIFO, Messages and Mailbox, Circular and swinging buffers, RPC					
Module:7	Memory Management	2 hours			
Memory Management, shared memory					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	
Text Book(s)					
1.	Herma K., Real Time Systems, Design for distributed Embedded Applications, 2011, 2 nd edition, Springer, USA.				
2.	Tanenbaum, Andrew, Modern Operating Systems, 2015, 4 th ed., Pearson Prentice Hall, USA				
Reference Books					
1.	Ivan CibrarioBertolotti, Politecnico di Torino and Gabriele Manduchi, Real-Time Embedded Systems: Open-Source Operating Systems Perspective, 2012, 1 st ed., CRC Press, USA				

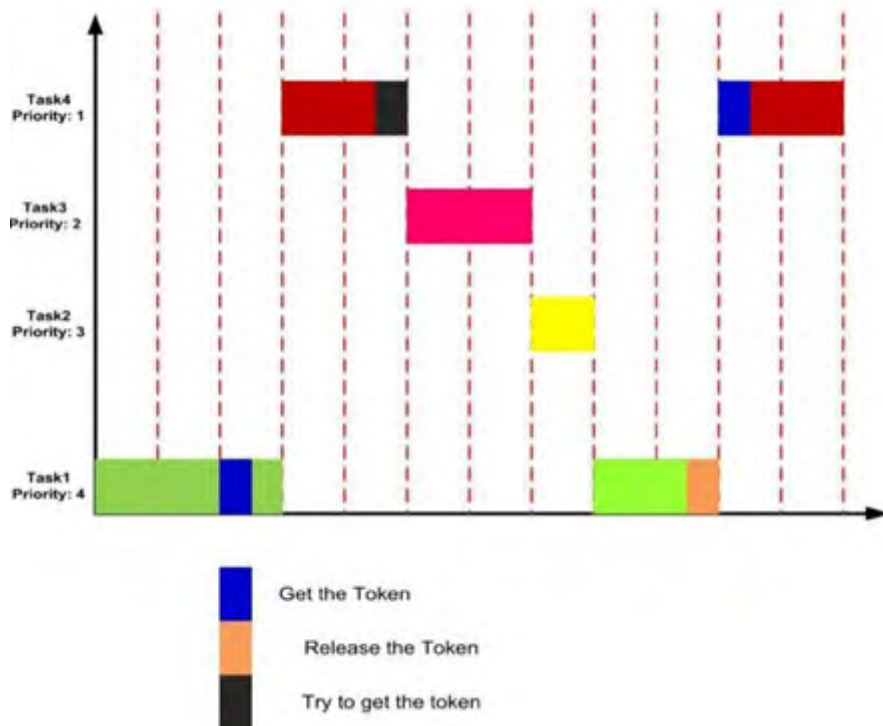
2.	Lyla B. Das, Embedded Systems an Integrated Approach, 2012, 1 st ed., Pearson Education, India.		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
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Course Code	Course Title	L	T	P	C
MEDS505P	Real Time Operating System Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at					
<ol style="list-style-type: none"> 1. Introducing the students about Operating Systems and acquainting students to Real Time Operating Systems 2. Teaching the students about Task Management and Enabling students to understand RTOS Scheduling 3. Introducing the students about interprocess communication and Memory Management 					
Course Outcome					
At the end of the course the will should be able to					
<ol style="list-style-type: none"> 1. Comprehend the basic components of an operating system 2. Learn about the basics of real-time concepts 3. Acquire knowledge about task management 4. Acquaint with RTOS scheduling 5. Learn about IPC synchronization 6. Learn about IPC data exchange 7. Perform memory management in RTOS 8. Apply the knowledge for developing practical applications of modern real-time systems. 					
Indicative Experiments					
1.	Write a C code for a simple calculator (+, -, *, /) using functional pointer as argument in a function <pre>int add (int x, int y) int sub (int x, int y) intmul (int x, int y) int div (int x, int y) int (*mathop)(int, int) intdomath(int (*mathop)(int , int), int x, int y)</pre>	6 hours			
2.	Write a program to create multiple threads carrying out different functions. Thread 1: Accepting a string from the user. Thread 2: Display the string in upper case. Thread 3: Count the number of vowels in the string Thread 4: Count the number of special characters in the string.	6 hours			
3.	Write a program to create three threads, which are implemented using function pointers. First thread is for getting a list of numbers from the keyboard, second thread is helpful to extract the ODD and EVEN list from the given list, and the third one is used to arrange the ODD and EVEN list of numbers in an order. Use Mutex semaphore. Note: First Thread for getting input data from keyboard. Second Thread to identify the ODD and EVEN list Third Thread to get descending ordered ODD list Fourth Thread to get ascending ordered EVEN list Input data: 56, 23, 12, 64, 87, 02, 45, 88, 35, 67.	6 hours			
4.	Write a Vx Works code for the given scenario. Also identify the proper mechanism to avoid this problem.	6 hours			



5. Write a VxWorks code for the given scenario. Also identify the proper mechanism to avoid this problem.

6 hours



Total Laboratory Hours 30 hours

Mode of Assessment: Continuous Assessment and Final Assessment Test

Recommended by Board of Studies 28-07-2022

Approved by Academic Council No. 67 Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS506L	Wireless and Mobile Communication	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course aimed at					
<ol style="list-style-type: none"> To know about wireless mobile communication system & related issues, and To keep abreast of the future of mobile communication 					
Course Outcome					
The students will be able to					
<ol style="list-style-type: none"> Get introduced Cellular Mobile Communication systems Understand and solve telecommunication design issues using cellular and trunking theory. Analyze the effect of multipath channels and suggest a suitable model for indoor or outdoor applications. Demonstrate the implications of multipath parameters in mobile communication. Will train the Channel coding for Mobile Radio Interpret the Modulation techniques for Mobile Radio Get introduced to Advanced Communication Systems and Wireless Standards 					
Module:1	Cellular Mobile Systems	4 hours			
Cellular Mobile Communication Evolution - Types of mobile wireless services/systems – 1G & 2G Mobile Communication Technology					
Module:2	Cellular Concept	7 hours			
Cellular concept – Frequency reuse – Channel assignment strategies – Handoff strategies – Interference & system capacity – Trunking & Grade of service – Improving coverage and capacity in cellular system.					
Module:3	Mobile Radio Propagation	9 hours			
Free Space Propagation Model – Basic Propagation mechanism – Two Ray Ground Reflection (Two Ray) model – Outdoor Propagation Models: Okumura Model, Hata Model – Indoor Propagation Model: Attenuation Factor Model.					
Module:4	Small Scale Propagation models	4 hours			
Parameters of mobile multipath channels – Types of small scale fading – Fading effects due to Multipath time delay spread and Doppler spread					
Module:5	Information Theory and Coding	6 hours			
Information and entropy - Coding of memoryless sources: Shannon-Fano / Huffman coding - Sources with memory: Markov model – Source Coding: Linear and non-linear quantisation, companding - Channel Coding: Convolutional coding, Viterbi decoding, LBC, Turbo Codes.					
Module:6	Multiplexing & Modulation Schemes	6 hours			
Shared memory, FIFO, Messages and Mailbox, Circular and swinging buffers, RPC					
Module:7	Advanced Communication Systems and Wireless Standards	7 hours			
3G, 4G and 5G and beyond wireless standards – WLAN Architecture design and WIMAX – VANETS					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	
Text Book(s)					
1.	Randy L. Haupt, Wireless Communications Systems: An Introduction, Wiley-IEEE Press, January 2020.				
2.	T.S.Rappaport, Wireless Communication -Principle and Practice ,Prentice Hall, 2010.				
Reference Books					

1.	W.C.Y.Lee, Wireless and Cellular Communication, McGraw Hill, 2006		
2.	Schiller, Mobile Communications; Pearson Education Asia Ltd., 2008		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title		L	T	P	C
MEDS507L	Electronic Hardware System Design		2	0	0	2
Pre-requisite	NIL	Syllabus version		1.0		
Course Objectives						
The course is aimed at						
<ol style="list-style-type: none"> 1. Emphasizing students the significant role of FPGA in System design and development. 2. Teaching the students to develop program using Hardware Descriptive Language and model digital logic combinational and sequential circuits. 3. Enabling the students acquire knowledge in Interfacing peripherals, Board Design, Packaging, PCB Design and Analysis 4. Motivating students to solve real life problem using FPGA based systems. 						
Course Outcome						
At the end of the course the student will be able to						
<ol style="list-style-type: none"> 1. Comprehend the architecture of FPGA and design flow 2. Understand Hardware Description Language 3. Design and develop combinational logic circuits using Verilog and VHDL program. 4. Design and develop sequential logic circuits using Verilog and VHDL program. 5. Interface peripherals with FPGA. 6. Design the PCB 7. Design FPGA based system 8. Comprehend upcoming trends in FPGA. 						
Module:1	Programmable Logic Devices & FPGAs	4 hours				
Introduction to FPGAs, FPGA technologies, FPGA Architectures [Xilinx, Altera, ACTEL, LATTICE], FPGA Design Flow Prototyping with Xilinx FPGAs, FPGA based Testing.						
Module:2	Hardware Descriptive Language (Verilog/VHDL)	3 hours				
Cellular concept – Frequency reuse – Channel assignment strategies – Handoff strategies – Interference & system capacity – Trunking & Grade of service – Improving coverage and capacity in cellular system.						
Module:3	Modeling of Combinational logic circuits	3 hours				
Free Space Propagation Model – Basic Propagation mechanism – Two Ray Ground Reflection (Two Ray) model – Outdoor Propagation Models: Okumura Model, Hata Model – Indoor Propagation Model: Attenuation Factor Model.						
Module:4	Modeling of Sequential logic circuits	4 hours				
Flip Flops-Realization of Shift Register -Realization of a Counter-Synchronous and Asynchronous – BCD counter, Mealy and Moore State Machines, Sequence detector, FIFO, Memory Design, Serial Data Receiver, Serial to parallel data converter.						
Module:5	Interfacing peripherals and Board Design	5 hours				
Interfacing to 7 segment display, Stepper Motor, ADC and Sensors, FPGA System Architecture, Constraints –Logical –Electrical -Physical, Power distribution for FPGAs, Clock design, I/O buses						
Module:6	Introduction to Packaging &PCB Design	4 hours				
Physical integration of circuits, packages, boards and full electronic systems - Package classifications (Through hole and SMDs) and packaging trends, Hierarchy of Interconnection Levels -Signal integrity - The PCB Design Process - Defining the Layout Cross Section - Design Rules Checking - Working with Properties & Constraints- PCB Electrical Design Consideration - Design tips for Placement / Fan-out and Wiring - Multi - Layer Design Issues.						
Module:7	High Speed PCB design and Analysis Wireless Standards	5 hours				
High speed PCB design -EMI/EMC analysis - Thermal management of electronic devices and systems -Thermal interface material, Cooling mechanisms-System level design of electronic hardware for automotive applications -System level testing and validation of						

automotive electronics systems for reliability. Layout constraints for FPGAs, FPGA-based PCB schematics.			
Module:8	Contemporary Issues	2 hours	
		Total Lecture hours:	30 hours
Text Book(s)			
1.	Simon Monk, Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards, 2014, First Edition, McGraw Hill Education, India.		
2.	Wayne Wolf, FPGA-based System Design, 2011, Re-Print, Prentice Hall, India		
Reference Books			
1.	Clyde Coombs, Printed Circuits Handbook, 2011, Sixth Edition, McGraw Hill Professional, USA		
2.	Ian Grout, Digital Systems, Design with FPGAs and CPLDs, 2012, Re-Print, Newness, UK.		
3.	Ronald R. Sass and Andrew Schmidt, Embedded Systems Design with Platform FPGAs: Principles and Practices, 2010, First Edition, Morgan Kaufman Publishers, USA.		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title			L	T	P	C
MEDS507P	Electronic Hardware System Design Lab			0	0	2	1
Pre-requisite	NIL			Syllabus version			
				1.0			
Course Objectives							
The course is aimed at							
<ol style="list-style-type: none"> 1. Emphasizing students the significant role of FPGA in System design and development. 2. Teaching the students to develop program using Hardware Descriptive Language and model digital logic combinational and sequential circuits. 3. Enabling the students acquire knowledge in Interfacing peripherals, Board Design, Packaging, PCB Design and Analysis 4. Motivating students to solve real life problem using FPGA based systems. 							
Course Outcome							
At the end of the course the student will be able to							
<ol style="list-style-type: none"> 1. Understand Hardware Description Language 2. Design and develop combinational logic circuits using Verilog and VHDL program. 3. Design and develop sequential logic circuits using Verilog and VHDL program. 4. Interface peripherals with FPGA. 							
Indicative Experiments							
1.	Task 1: Combination Logic:- Design a 16-bit microprocessor that is capable of performing both logical and arithmetic operation.			8 hours			
2.	Task 2: Sequential Logic:- Design a controller for vending machine which sells candy bars for Rs 5, 10 and 20.			8 hours			
3.	Task 3: Peripheral Interfacing:- Design a car speed monitor using the following components (a) 7 segment display (b) LEDs (c) Switches for speed selection and (d) Buzzer. The cars electronic speedometer provides a clock signal whose frequency is proportional to the speed. To check the functioning of the design use function generator to provide the speedometer clock.			8 hours			
4.	Task 4:PCB Design:- Design a PCB for a circuit with a mixture of analog and digital parts, multiple power planes, and a single Ground plane split into analog and digital sections that have a common reference point using open source tool.			6 hours			
Total Laboratory Hours							30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test							
Recommended by Board of Studies				28-07-2022			
Approved by Academic Council				No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MEDS601L	Electromagnetic Interference and Compatibility in ESD	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at:					
<ol style="list-style-type: none"> 1. Imparting knowledge about EMI environment 2. Teaching EMI coupling principles, EMI control techniques and design of PCBs for EMC 3. Giving exposure to EMI Standards, Regulations and Measurements 					
Course Outcome					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> 1. Understand terminologies of EMI and EMC 2. Analyze and understand various EMI coupling mechanisms 3. List various EMI Test and Measurement methods 4. Analyze various techniques needed to suppress EMI 5. Perceive different EMC regulations followed worldwide 6. Ability to design an Electromagnetic Compatible systems. 7. Analyze and comprehend different techniques needed for Signal Integrity and ability to understand various models for EMI/EMC 					
Module:1	EMI Environment	4 hours			
EMI-EMC Definitions and units of Parameters, Sources of EMI, conducted and radiated EMI, Transient EMI					
Module:2	EMI Coupling Mechanisms	6 hours			
Conducted, Radiated and Transient Coupling, Common Impedance Ground Coupling, Radiated Common Mode and Ground Loop Coupling, Radiated Differential Mode Coupling, Near Field Cable to Cable Coupling, Power Mains and Power Supply Coupling.					
Module:3	EMI Test and Measurements	8 hours			
EMI Specification / Standards / Limits: Units of specifications, Civilian standards Military standards. EMITestInstruments/Systems, EMITest, EMIShieldedChamber, OpenAreaTest Site, TEM Cell Antennas, Conductors Sensors/Injectors/Couplers. EMI Measurement Methods: Military Test Method and Procedures, Calibration Procedures, Modeling interferences					
Module:4	EMI Control Techniques	7 hours			
Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal Control, Component Selection and Mounting, Electrostatic discharge protection schemes					
Module:5	EMC Standards and Regulations	5 hours			
National and Intentional standardizing organizations- FCC, CISPR, ANSI, DOD, IEC, CENECEC, FCC CE and RE standards, CISPR, CE and RE Standards, IEC/EN, CS standards, SAE Automotive EMC standard, Frequency assignment - spectrum conversation.					
Module:6	System Design for EMC	8 hours			
PCB Traces Cross Talk, Impedance Control, Power Distribution Decoupling, Zoning, Motherboard Designs and Propagation Delay Performance Models, System Enclosures, Power line filter placement, Interconnection and Number of Printed Circuit Boards, PCB and subsystem decoupling					
Module:7	Signal Integrity and EMI/EMC Models	5 hours			
Effect of terminations on line wave forms, Matching schemes for Signal Integrity, Effects of line discontinuities, Statistical EMI/EMC models.					

Module:8	Contemporary Issues	2 hours	
		Total Lecture hours:	45 hours
Text Book(s)			
1.	Clayton R. Paul, Introduction to Electromagnetic Compatibility, 2010, 2nd ed., Wiley & Sons, New Jersey		
Reference Books			
1.	Henry W. Ott, Electromagnetic Compatibility Engineering, 2011, 1st ed., John Wiley and Sons, New Jersey.		
2.	Patrick G. André and Kenneth Wyatt, EMI Troubleshooting Cookbook for Product Designers 2014, 1st ed., SciTech Publishing, New Jersey		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS602L	Advanced Digital Image Processing	3	0	0	3
Pre-requisite	NIL	Syllabus version			
1.0					
Course Objectives					
The course is aimed at:					
<ol style="list-style-type: none"> 1. Revising the basics of digital image processing namely; image acquisition, digitizing, enhancing images in spatial domain, image transforms and enhancing images in frequency domain. 2. Enabling the students to acquire knowledge in image restoration, image compression, image segmentation and object recognition. 3. Motivating the students to apply image processing and classification algorithms for solving real life problems and introducing students to upcoming trends in Computer Vision. 					
Course Outcome					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> 1. Comprehend the image acquisition, digitization, and processing in spatial domain. 2. Understand algorithms and programs for processing an image in transform domain 3. Acquaint with the image enhancement and restoration techniques 4. Implement different compression techniques to compress an image 5. Adopt different segmentation and image representation techniques for image processing. 6. Understand the pattern recognition approaches for implementing the visual system. 7. Identify computer vision techniques in various real-time applications. 					
Module:1	Image Processing in Spatial Domain	7 hours			
Fundamental steps in DIP – Elements of visual perception - Image Sampling and Quantization - Basic relationship between pixels. Image enhancement - Spatial Domain: Basic Grey level Transformations – Histogram Processing – Smoothing spatial filters- Sharpening spatial filters. Colour image Processing: Models, Transformation					
Module:2	Image Transforms	6 hours			
Image Transforms: Two dimensional Fourier Transform- Discrete cosine transform - Multi-resolution analysis – Haar Transform- Discrete Wavelet Transform. Karhunen – Loeve transform. and SVD					
Module:3	Frequency domain filtering and Image Restoration	6 hours			
Smoothing frequency domain filters- sharpening frequency domain filters- Homomorphic filtering. Image Restoration: Image deformation and geometric transformations, Restoration techniques, Noise characterization, Linear, Position invariant degradations, Adaptive filters.					
Module:4	Image Compression	6 hours			
Image Compression Techniques - Lossy and Lossless compression- Entropy Encoding- JPEG and MPEG standards					
Module:5	Image Segmentation	7 hours			
Detection of discontinuities – point, corner, edge detection- thresholding -edge based segmentation-region based segmentation- morphological segmentation - watershed algorithm Descriptors: Boundary descriptors-Region descriptors- Texture descriptors, RANSAC.					
Module:6	Recognition and Classification	7 hours			
Patterns and pattern classes – Introduction to classification – Decision theoretic methods –					

structural and syntactic classifiers – Clustering techniques – similarity measures – hierarchical methods – K-Means algorithm – Cluster evaluation methods. Convolution neural networks, Region-based CNN, fully convolution networks, Multi-modal networks, Hybrid learning methods.			
Module:7	Computer Vision Applications		4 hours
Face recognition application: personal photo collections – Instance recognition application : Location recognition – Machine learning applications: Deep voting, transfer learning and structured regression for image analysis and categorization.			
Module:8	Contemporary Issues		2 hours
Total Lecture hours:			45 hours
Text Book(s)			
1.	Rafael C. Gonzalez & Richard E. Woods, “Digital Image Processing”, 4th Edition, 2018, Pearson, USA		
2.	David A. Forsyth and Jean Ponce, “Computer Vision: A Modern Approach”, 2nd Edition, 2012, Prentice Hall, Pearson Education		
Reference Books			
1.	Richard Szeliski, “Computer vision: Algorithm and Applications”, Springer- Verlag, London, 2010.		
2.	K. Jain, Fundamentals of Digital Image Processing, 2015, 3rd Edition, Pearson Education, USA.		
3.	K.P.Soman, K.I. Ramchandran, N.G.Resmi, Insights into Wavelets, From Theory to Practice, 2013, 3rd Edition, PHI Learning Private Limited, New Delhi, India.		
4.	Mark Nixon & Alberto Aguado, Feature Extraction, and Image Processing, 2013, 3rd Edition, Elsevier’s Science & Technology Publications, USA		
5.	William K. Pratt, Digital Image Processing, 2013, John Wiley & Sons, USA.		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS603L	Design and Analysis of Algorithms	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
This course is aimed at					
<ol style="list-style-type: none"> 1. Enabling the students to carry out analysis of various algorithms for mainly time and space complexity. 2. Teaching the students how to decide the appropriate data type and data structure for a given problem. 3. Teaching the students how to select the best algorithm to solve a problem by considering various problem characteristics, such as the data size, the type of operations, etc. 					
Course Outcome					
At the end of the course the student will be able to					
<ol style="list-style-type: none"> 1. Develop proficiency in problem solving and programming. 2. Comprehend Combinatorial Optimization 3. Analyse various algorithms for mainly time and space complexity. 4. Comprehend Cryptographic Algorithms 5. Learn Geometric Algorithms 6. Analyse Parallel Algorithms 7. Analyse and evaluate the given program in terms of code size and computational time. 8. Select the best algorithm to solve a problem by considering various problem characteristics, such as the data size, the type of operations, etc. 					
Module:1	Introduction	7 hours			
Role of Algorithms in computing, Analysis of Algorithms, Asymptotic notation, Euclid's algorithm, Problem, Instance, RAM model, Principles of Algorithm Design, Sorting Algorithm - Insertion Sort & Complexity Analysis, Divide and Conquer Technique, Solving recurrences - substitution, Iteration, Recursion tree, Changing variable and Master's Method.					
Module:2	Combinatorial Optimization	5 hours			
Backtracking; Dynamic programming; Greedy Technique ; Branch & Bound					
Module:3	Advanced Algorithmic Analysis	5 hours			
Amortized analysis; Online and offline algorithms; Randomized algorithms, NP Completeness					
Module:4	Cryptographic Algorithms	9 hours			
Historical overview of cryptography; Private-key cryptography and the key-exchange problem; Public-key cryptography; Digital signatures; Security protocols; Applications (zero-knowledge proofs, authentication etc..					
Module:5	Geometric Algorithms	7 hours			
Line segments: properties, intersections; convex hull finding algorithms, Voronoi Diagram, Delaunay Triangulation					
Module:6	Parallel Algorithms	5 hours			
PRAM model; Exclusive versus concurrent reads and writes; Pointer jumping; Brent's theorem and work efficiency .					
Module:7	RNNs, Auto encoders and GANs	5 hours			
Consensus and election; Termination detection; Fault tolerance; Stabilization;					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					45 hours
Text Book(s)					

1.	Anany Levitin, "Introduction to the Design and Analysis of Algorithms". 3rd edition.,2011, Addison Wesley , 2011		
2.	Cormen, Leiserson, Rivest and Stein , "Introduction to Algorithms", 3rd edition, McGraw-Hill, 2009		
Reference Books			
1.	Ellis Horowitz, "Fundamentals of Computer Algorithms", 2nd Edition, Universities Press, 2008		
2.	M. J. Quinn, Parallel computing – theory and practice, McGraw Hill, 2002		
3.	Sukumar Ghosh, "Distributed Systems: An Algorithmic Approach" ,1 st edition, Chapman & Hall/CRC Computer & Information Science Series, 2006		
4.	William Stallings, "Cryptography & Network Security", 4th Edition , Prentice Hall, 2005		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS604L	Embedded System Design using FPGA	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at					
<ol style="list-style-type: none"> 1. Provide in depth understanding of logic and system design. 2. Enabling the students to apply their knowledge for the design of advanced digital hardware systems with help of FPGA tools 3. Teaching the students scheduling and communication with respect to FPGA 					
Course Outcome					
At the end of the course, the Students will be able to					
<ol style="list-style-type: none"> 1. Comprehend overview of Embedded System 2. Learn Hardware Description Languages 3. Acquire abilities to Design an embedded system using FPGA 4. Use Xilinx IP Cores 5. Comprehend Partitioning concepts 6. Comprehend Scheduling & Communication 7. Identify and exploitation of Parallelism concepts 8. Use state-of-art hardware and software to solve real life problems 					
Module:1	Embedded System Overview	4 hours			
H/W-FPGA-Embedded SoC and use of VLSI circuit technology-platform FPGA's-Altera Cyclone					
Module:2	Hardware Description Languages	4 hours			
Hardware Description Languages - VHDL , Verilog , Other High-Level HDLs, From HDL to Configuration Bit-stream					
Module:3	System Design using FPGA	4 hours			
Principles of system design-Design quality, Modules and interfaces, Abstraction and state, Cohesion and coupling, Designing and Reuse, Control flow graph, Design-Origins of platform FPGA designs					
Module:4	FPGA Platform	4 hours			
Components, Adding to platform FPGA systems, assembling custom compute cores. Software Design-System Software Options, Root File system, Cross-Development Tools, Monitors and Boot-loader.					
Module:5	Partitioning	4 hours			
Overview of Partitioning Problem, Analytical Solution to Partitioning-Basic definitions, Expected performance gain, Resource considerations, Analytical Approach					
Module:6	Scheduling & Communication	4 hours			
Communication-Invocation/Coordination, Transfer of State, Practical Issues- Profiling Issues, Data Structures Manipulate Feature Size					
Module:7	Spatial Design	4 hours			
Principles of Parallelism-Identifying Parallelism - Spatial Parallelism with Platform FPGAs- Parallelism within FPGA Hardware Cores, Parallelism within FPGA Designs					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		30 hours	
Text Book(s)					
1.	Ron Sass, Andrew G Schmidt Embedded Systems Design with Platform FPGAs Principles and Practices, 2011, First Edition, Tata McGraw Hill, India.				
Reference Books					

1.	Charles H Roth. Jr Digital Systems design using VHDL, 2012, Re-Print, PWS publishing company (Thomson Books), USA.		
2.	V A. Padroni Circuit Design with VHDL 2011, First Edition, MIT Press Cambridge, England.		
3.	Wayne Wolf, FPGA Based System Design, 2011, First Edition, Prentices Hall Modern Semiconductor Design Series, USA.		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS604P	Embedded System Design using FPGA Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at					
<ol style="list-style-type: none"> 1. Provide in depth understanding of logic and system design. 2. Enabling the students to apply their knowledge for the design of advanced digital hardware systems with help of FPGA tools 3. Teaching the students scheduling and communication with respect to FPGA 					
Course Outcome					
At the end of the course, the Students will be able to					
<ol style="list-style-type: none"> 1. Comprehend overview of Embedded System 2. Learn Hardware Description Languages 3. Acquire abilities to Design an embedded system using FPGA 4. Use Xilinx IP Cores 5. Comprehend Partitioning concepts 6. Comprehend Scheduling & Communication 7. Identify and exploitation of Parallelism concepts 8. Use state-of-art hardware and software to solve real life problems 					
Indicative Experiments					
1	Task-1 Modelling of combinational digital design such as Mux, DeMux, Encoder, Decoder, ALU using Verilog Programming	7 hours			
2	Task-2 Modelling of Sequential digital design using Verilog Programming	7 hours			
3	Task-3: FSM modelling of Digital Systems and IP(Intellectual Property) based System using Verilog Programming	8 hours			
4	Task-4: Developing embedded applications using external peripherals such as Seven Segment Display, Temp Sensor, WiFi , Motors using platform FPGA	8 hours			
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MEDS605L	Hardware Software Co-design	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at					
<ol style="list-style-type: none"> 1. Providing adequate knowledge in the modeling of heterogeneous embedded systems based on design constraint and provide alternate solution exploring trade-off. 2. Introducing the importance of estimating the cost analysis in terms of hardware and software parameters. 3. Introducing various co-synthesis and co-simulation tools for the effective design of embedded systems with better communication between different modules. 					
Course Outcome					
At the end of the course, the Students will be able to					
<ol style="list-style-type: none"> 1. Apply different MOCs based on system design specification. 2. Propose an alternate design solution based on constraint analysis. 3. Identify the partitioning solution based on the algorithms. 4. Understand various co-synthesis approaches. 5. Ability to pre-estimate and estimate the performance metrics for hardware and software based on cost analysis. 6. Approximate the pre-estimate and estimate the performance metrics for software based cost analysis. 7. Decide on proper co-simulation method based on system specification. 					
Module:1	Specification of embedded systems	4 hours			
Introduction to Co-design - Comparison of co-design approaches – Unified representation-Model-MoCs: State oriented, Activity oriented, Structure oriented, Data oriented and Heterogeneous –Software CFSMs–Processor Characterization.					
Module:2	HW/SW partitioning Constraints & tradeoffs	4 hours			
Cost modeling, Principle of hardware / software mapping - Real time scheduling - design specification & constraints on Embedded systems -Tradeoffs					
Module:3	HW/SW partitioning methodologies	4 hours			
Partitioning - Types of partitioning – Partition in granularity – Kernigan -Lin Algorithm-Extended Partitioning – Binary Partitioning: GCLP Algorithm					
Module:4	Co-synthesis	4 hours			
Software synthesis – Hardware Synthesis- Interface Synthesis – Co-synthesis Approaches: Vulcan, Cosyma, Cosmos, Polis and COOL.					
Module:5	Estimation: Hardware	4 hours			
Hardware area, execution timing and power, Case studies					
Module:6	Estimation: Software	4 hours			
Software memory and execution timing, Worst Case Execution Time, Case studies					
Module:7	Co-simulation & Co-verification	4 hours			
Principles of Co-simulation – Abstract Level; Detailed Level – Co-Simulation as Partitioning support – Co- simulation using Ptolemy approach, Virtual Prototyping, Rapid Prototyping.					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					
					30 hours

Text Book(s)			
1	Soonhoi Ha, Jürgen Teich, "Handbook of Hardware/Software Co-design", Springer, 2017		
Reference Books			
1	Schaumont, Patrick, A," A Practical Introduction to Hardware/Software Codesign", 2013, reprint, Springer, India.		
2	FeliceBalarin, Massimiliano Chiodo, Paolo Giusto, Harry Hsieh, Attila Jurecska, Luciano Lavagno, Claudio Passerone, Alberto Sangiovanni - Vincentelli, Ellen Sentovich, Kei Suzuki, BassamTabbara, "Hardware-Software Co-Design of Embedded Systems: The POLIS Approach", Springer, 2012.		
3	http://ptolemy.eecs.berkeley.edu/ptolemyII/ptII10.0/ptII10.0.1_20141217/ptolemy/domains/continuous/doc/index.htm		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS606L	Modern Automotive Electronics Systems	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at					
<ol style="list-style-type: none"> 1. Instilling fundamental understanding of various automatic control systems and basic instrumentation involved in automobiles. 2. Learning various automobile condition measurement and monitoring mechanisms. 3. Acquire with advanced electronic elements and their functional aspects in automobiles 					
Course Outcome					
At the end of the course the student will be able to					
<ol style="list-style-type: none"> 1. Comprehend engine management system. 2. Understand the various Ignition and Injection systems 3. Explain the automotive control mechanisms. 4. Learn the different monitoring systems for automobiles 5. Understand the typical sensors for transportation. 6. Acquire knowledge about upcoming trends in automotive electronics systems 7. Use the knowledge attained and develop appropriate systems for societal issues 					
Module:1	Engine management systems	8 hours			
Introduction - components for engine management system - Open loop and closed loop control system – Engine cranking and warm up control –Acceleration, deceleration and idle speed control.					
Module:2	Injection and ignition systems	8 hours			
Feedback carburetor system–Throttle body injection and multi point fuel injection system– Injection system controls –Advantage of electronic ignition systems–Types of solid state ignition systems and their principles of operation –Electronic spark timing control, Exhaust emission control engineering					
Module:3	Automotive control mechanism	6 hours			
Electronic management of chassis systems, Vehicle motion control, anti – lock braking system, Tyre pressure monitoring system, Collision avoidance system, Traction control system.					
Module:4	Automotive Electronics systems	6 hours			
Active suspension system Keyless entry system and Electronic power steering system, Electronic controls - lighting design - Horn – Warning systems – Brake actuation warning systems, Infotainment					
Module:5	Monitoring of Automotive systems	6 hours			
Speed warning systems, oil pressure warning system, engine over heat warning system, air pressure warning system, safety devices-Wind shield wiper and washer, VANET					
Module:6	Sensors for transportation - I	5 hours			
Basic sensor arrangement–Types of sensors, Oxygen Sensor –Cranking Sensor –Position Sensors					
Module:7	Sensors for transportation - II	4 hours			
Engine cooling water temperature Sensor–Engine oil pressure Sensor–Fuel metering – Vehicle speed sensor and detonation sensor.					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	
Text Book(s)					
1. Tom Denton, Automobile Electrical and Electronic Systems, 2012, 4 th Edition,					

	Butter Worth Heinemann, United States		
2.	Bosch Automotive Electrics and Automotive Electronics, 2014, 5 th Edition, Springer Vieweg, United States		
3.	Beckwith, T.G, Roy D.Marangoni, John H.Lienhard, Mechanical Measurements, 2011, 6 th Edition, Addison Wesley, United States		
Reference Books			
1.	Ernest O Doebelin, Measurement Systems, Application and design, 2013, 5 th Edition McGraw Hill Book Co., United States		
2.	Holman, J.P, Experimental methods for Engineers, McGraw Hill Book Co., 2011, 8 th Edition, United States		
3.	Robert Bosch Gmph, Automotive Hand Book, 2014, 9 th Edition, Wiley, United States		
4	William, B. Ribbens, Understanding Automotive Electronics, 2014, 8 th Edition Butter Worth Heinemann, United States		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MAME602L	AUTOSAR and ISO Standards for Automotive Systems	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at:					
<ol style="list-style-type: none"> 1. Enabling the students to understand Autosar standards 2. Introducing to the students the basic knowledge of Communication Stack in Autosar 3. Preparing the students to understand the implementation and integration in Autosar 					
Course Outcome					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> 1. Apply the knowledge of various autosar standards 2. Analyze autosar codes 3. Apply the AutoSAR – Implementation Integration 4. Analyze the AutoSAR – System Services 5. Implement CAN programming concepts through Autosar 6. Analyze the ISO/TS 16949 standards 7. Know the implementation aspects of ISO/TS 16949 standards 					
Module:1	AutoSAR Standards	3 hours			
General requirement on basic software modules – Functional, Fault operation and error detection.					
Module:2	AutoSAR Standards – Communication Stack	5 hours			
Network Management, TTCAN Interface standards, TTCAN Drivers					
Module:3	AutoSAR – Implementation Integration	3 hours			
Platform Types, Memory Mapping					
Module:4	AutoSAR – System Services	3 hours			
Watchdog Manager, Synchronized Time Base Manager					
Module:5	ISO/TS 16949	5 hours			
ISO/TS 16949 - ISO/TS 16949:2009 specifies the quality system requirements for the design and development, production, installation and servicing of automotive related products.					
Module:6	Introduction to ISO26262 Standard: Basic Concepts	3 hours			
Structure of ISO26262 standard and its parts-Vocabulary-Management of functional Safety-Concept Phase					
Module:7	Introduction to ISO26262 Standard: Implementation Aspects	6 hours			
Product Development System level-Product Development Hardware level-Product Development Software level-Production and Operation-Supporting Processes-ASIL Oriented and Safety Oriented Analysis-Guidelines on ISO26262 (Informative)-Case Studies to illustrate concepts, Hazard analysis and Risk assessment-Safety Goals, Preliminary Architecture-Functional Safety Concept					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		30 hours	
Text Book(s)					
1.	Automotive Quality systems – David Hoyle, Butterworth Heinemann limited, 2000				
Reference Books					
1.	www. autosar.org				
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MEDS608L	Intelligent IOT System Design and Architecture	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at:					
<ol style="list-style-type: none"> 1. To explore the characteristics of the Internet of things and its design. 2. To enable the students to get familiar with IoT architecture models. 3. To acquaint the students with various security concepts and data analytics in the IoT system. 4. To develop and deploy an IoT enabled prototypes for real-life use cases. 					
Course Outcome					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> 1. Assimilate the technologies that enable IoT and to interpret the different components in IoT architecture. 2. Comprehend the concepts of edge computing and edge enabled solutions for real-time industrial applications. 3. Envision the IoT communication architecture models and the protocol stack for the cost-effective design of IoT applications on different platforms. 4. Interpret the security threats and to design a resilient IoT Architecture. 5. Perceive the data analytics tools and gain knowledge to devise an intelligent IoT system. 6. Analyze cloud platform services to perform IoT data analytics and make the system intelligent. 7. Design and develop smart IoT prototypes for use cases under discussion. 					
Module:1	IoT Essentials	4 hours			
Evolution of IoT, IoT characteristics, IoT enabling technologies, Planning for an IoT solution, IoT use case development - Need and goals, IoT Architecture reference model, Functional blocks of IoT- Communication and security Model, Service oriented architecture, Event-driven architecture, Applications and standards.					
Module:2	Edge Computing	5 hours			
Introduction to Edge/Fog computing, Edge nodes and gateway, Node to edge interfaces, Protocol and standards for edge devices, IoT edge architecture, IoT supported hardware- Raspberry pi, ARM Cortex Processors, Software Platforms for IoT Edge - Raspbian Pi OS, RIOT, Python packages for edge computing, Edge security, Real time applications of edge computing.					
Module:3	IoT Communication Architecture and Protocols	5 hours			
Communication models for IoT, 6LoWPAN, IPv4/IPv6, IoT communication protocols - MQTT, CoAP, LoRaWAN, RTLS, RPL, Communication API's.					
Module:4	IoT Security and Privacy	4 hours			
IoT risks and security challenges, IoT security architecture - A trust model, Restricting network access through security groups- Specific user access control, Data confidentiality and availability, User Authentication/Authorization methods, Block chain for IoT security and privacy.					
Module:5	Smart Data Analytics	4 hours			
Need for data analytics, Data generation, Data pre-processing, Handling imbalanced data sets, Missing values, Outliers, Intelligent IoT systems –Supervised and Unsupervised machine learning algorithms, Deep learning for IoT- Predictive analytics, Python functions and modules for data analytics, Big Data analytics and frameworks					
Module:6	Data Analytics in Cloud Concepts	4 hours			
Layered cloud architecture for data analytics, Elasticity in cloud for data warehousing,					

Virtualization for Data-center automation, Real-time cloud data analytics tools, AI Services-Data based decisions, Cloud data lake, Exploratory data analysis, Open source cloud platforms and services.			
Module:7	IoT Architecture for specific use cases	2 hours	
Roadmap for complete IoT solution, Open source IoT platforms, IoT solution to Health care, Automotive applications, Smart IoT architecture for Retail, Logistics and Farming, Intelligent IoT architecture for Home automation, Industry applications, Smart city and other applications to cater the societal requirements.			
Module:8	Contemporary Issues	2 hours	
Total Lecture hours:			
			30 hours
Text Book(s)			
1.	Arshdeep Bahga, Vijay Madiseti, "Internet of Things – A hands-on approach", Universities Press, 2015.		
2.	John R. Vacca, "Cloud Computing Security: Foundations and Challenges", CRC Press, 2016.		
3.	Dey, Hassanien, Bhatt, Ashour and Satapathy "Internet of Things and Big Data Analytics towards Next-Generation Intelligence", Springer, 2018.		
Reference Books			
1.	Adrian McEwen & Hakim Cassimally, "Designing the Internet of Things", Wiley, 2013.		
2.	Ovidiu Vermesan, Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers, 2013.		
3.	Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key applications and Protocols", Wiley Publication, 2012		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS608P	Intelligent IOT System Design and Architecture Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at: <ol style="list-style-type: none"> To explore the characteristics of the Internet of things and its design. To enable the students to get familiar with IoT architecture models. To acquaint the students with various security concepts and data analytics in the IoT system. To develop and deploy an IoT enabled prototypes for real-life use cases. 					
Course Outcome					
At the end of the course, the student will be able to <ol style="list-style-type: none"> Assimilate the technologies that enable IoT and to interpret the different components in IoT architecture. Comprehend the concepts of edge computing and edge enabled solutions for real-time industrial applications. Envision the IoT communication architecture models and the protocol stack for the cost-effective design of IoT applications on different platforms. Interpret the security threats and to design a resilient IoT Architecture. Perceive the data analytics tools and gain knowledge to devise an intelligent IoT system. Analyze cloud platform services to perform IoT data analytics and make the system intelligent. 					
Indicative Experiments					
1	Task-1 Program the gateways to interface the sensors and implement various IoT communication protocols to perform secured edge computing.				8 hours
2	Task -2 Explore the open source IoT platforms to build data driven intelligent Industry 4.0 applications using virtual things.				8 hours
3	Task-3: Build prototypes and explore UI/UX, data analytics tools for Internet of Medical Applications.				7hours
4	Task-4: Explore the open source cloud platforms to perform environmental monitoring / smart agriculture / internet of vehicles and other innovative intelligent IoT use cases.				7 hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MEDS609L	Fault Tolerance and Dependable Systems	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at:					
<ol style="list-style-type: none"> 1. Providing students with a working knowledge of the potential faults and errors occurring in an embedded system. 2. Providing knowledge in concepts of fault detection and fault tolerance. 3. Teaching students dependability concepts 4. Exposing the fault tolerance strategies and design techniques. 					
Course Outcome					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> 1. Gain knowledge in concepts involving fault detection 2. Comprehend dependability concepts 3. Understand tolerance and correction mechanisms in real world scenarios. 4. Design and develop dependable systems for mission critical applications. 5. Understand Fault tolerance in interconnected systems. 6. Understand Fault tolerance in distributed systems. 7. Apply Dependability evaluation techniques and Tools 					
Module:1	Faults and Failures	4 hours			
Fault - error, failure - faults and their manifestation - classification of faults and failures					
Module:2	Dependability Concepts	5 hours			
Dependable system - techniques for achieving dependability - dependability measures					
Module:3	Fault Tolerance Strategies	6 hours			
Fault detection – masking – containment – location – reconfiguration - recovery					
Module:4	Fault tolerant design techniques	8 hours			
Hardware redundancy - software redundancy - time redundancy - information redundancy					
Module:5	Fault tolerance in Interconnects	6 hours			
Hypercube - star graphs - fault tolerant ATM switches					
Module:6	Fault Tolerance in Distributed Systems	8 hours			
Byzantine General problem - consensus protocols - check pointing and recovery – stable storage and RAID architectures - data replication and resiliency					
Module:7	Dependability evaluation techniques and tools	6 hours			
Fault trees - Markov chains - HIMAP tool					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	
Text Book(s)					
1.	Israel Koren, C. Mani Krishna, Fault-Tolerant Systems, 2011, Morgan Kaufmann, San Francisco.				
2.	Elena Dubrova, Fault-Tolerant Design, 2013, Springer, Sweden.				
Reference Books					

1.	D. P. Siewiorek and R. S. Swarz, Reliable Computer Systems: Design and Evaluation, 2014, 3rd ed., Digital Press, Pennsylvania.		
2.	Alessandro Birolini, Reliability Engineering: Theory and Practice, 2017, 8 th ed., Springer-Verlag Berlin Heidelberg, Spain.		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS610L	Advanced Machine Learning and Deep Learning	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at					
<ol style="list-style-type: none"> 1. Understanding about the fundamentals of machine learning and neural networks 2. Enabling the students to acquire knowledge about pattern recognition. 3. Motivating the students to apply deep learning algorithms for solving real life problems. 					
Course Outcome					
At the end of the course the student will be able to					
<ol style="list-style-type: none"> 1. Comprehend the categorization of machine learning algorithms. 2. Understand the types of neural network architectures, activation functions 3. Acquaint with the pattern association using neural networks 4. Explore various terminologies related with pattern recognition 5. Adopt different feature selection and classification techniques 6. Understand the architectures of convolutional neural networks 7. Comprehend advanced neural network architectures such as RNN, Auto-encoders, and GANs. 					
Module:1	Learning Problems and Algorithms	4 hours			
Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms					
Module:2	Neural Network – I	4 hours			
Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation					
Module:3	Neural Network – II	4 hours			
Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organizing Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning					
Module:4	Machine Learning: Terminologies	4 hours			
Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance					
Module:5	Machine Learning: Feature Selection and Classification	4 hours			
Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.					
Module:6	Convolutional Neural Networks	4 hours			
Feed forward networks, Activation functions, backpropagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.					
Module:7	RNNs, Auto encoders and GANs	4 hours			
State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Auto encoders: Convolutional Auto encoders, De-noising auto encoders, Variational auto encoders, GANs: The discriminator, generator, DCGANs					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					30 hours

Text Book(s)			
1.	J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning		
2.	Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.		
Reference Books			
1.	The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.		
2.	Understanding Machine Learning. ShaiShalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title			L	T	P	C
MEDS610P	Advanced Machine Learning and Deep Learning Lab			0	0	2	1
Pre-requisite	NIL			Syllabus version			
				1.0			
Course Objectives							
The course is aimed at							
<ol style="list-style-type: none"> 1. Understanding about the fundamentals of machine learning and neural networks 2. Enabling the students to acquire knowledge about pattern recognition. 3. Motivating the students to apply deep learning algorithms for solving real life problems. 							
Course Outcome							
At the end of the course the student will be able to							
<ol style="list-style-type: none"> 1. Comprehend the categorization of machine learning algorithms. 2. Understand the types of neural network architectures, activation functions 3. Acquaint with the pattern association using neural networks 4. Explore various terminologies related with pattern recognition 5. Adopt different feature selection and classification techniques 6. Understand the architectures of convolutional neural networks 							
Indicative Experiments							
1	Task-1 Study of Python Basic Libraries such as Numpy, Scipy, pandas, matplotlib. Understand the basics of Tensorflow, keras and pytorch			7 hours			
2	Task-2 Write a Python program to implement Simple Linear Regression, Multiple Linear regression, prediction of housing prices using regression			7 hours			
3	Task-3: Write a Python program to perform classification using decision trees, random forests and KNN			8 hours			
4	Task-4: Implement image classification using convolutional neural networks, and audio classification using RNN and LSTM			8 hours			
						Total Laboratory Hours	30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test							
Recommended by Board of Studies				28-07-2022			
Approved by Academic Council				No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MEDS611L	Parallel Processing and Computing	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at					
<ol style="list-style-type: none"> Teaching the students to understand the scope, design and model of parallelism and to know the parallel computing architecture Teaching students to do analytical modelling and performance of parallel programs Teaching students to solve a complex problem with message passing model Programming with CUDA and analyse complex problems with shared memory programming 					
Course Outcome					
At the end of the course the student will be able to					
<ol style="list-style-type: none"> Understand the fundamentals of parallel processing Illustrate the scheduling loops and process execution Realize the parallel system architecture with CUDA Comprehend the kernel based parallel programming concepts Apply the performance consideration for parallel processing Analyse various parallel computation patterns Perform sparse matrix vector multiplications 					
Module:1	Introduction to Parallel Processing	5 hours			
Parallel processing – Concepts and Terminology- Parallel Computer Memory Architectures - Parallel Programming Models - Designing Parallel Programs- Performance Analysis					
Module:2	Shared Memory Programming	6 hours			
Processes and Threads - Scope of Variables – Reduction Clause – Directives – Scheduling Loops – Caches, Cache coherence and False Sharing – Thread Safety – Examples: Bubble-sort, Odd- even transposition sort					
Module:3	Parallel Computing	6 hours			
Portability and Scalability- Introduction to CUDA, Data Parallelism and Threads-Memory Allocation and Data Movement API- Kernel-Based SPMD Parallel Programming-Kernel based Parallel Programming, Multidimensional Kernel Configuration- Basic Matrix-Matrix Multiplication					
Module:4	Kernel-Based Parallel Programming	6 hours			
Thread Scheduling-Control Divergence- Memory Model and Locality - CUDA Memories-Tiled Parallel Algorithms- Tiled Matrix Multiplication- Tiled Matrix Multiplication Kernel-Handling Boundary Conditions in Tiling-- A Tiled Kernel for Arbitrary Matrix Dimensions					
Module:5	Performance Considerations	6 hours			
Warps and Thread execution - Global Memory Bandwidth - DRAM Bandwidth - Memory Coalescing -Dynamic partition of execution resources					
Module:6	Introduction to Packaging &PCB Design	8 hours			
Convolution- Tiled Convolution- 2D Tiled Convolution Kernel- Data Reuse in Tiled Convolution-Reduction- A Basic Reduction Kernel- Scan (Prefix Sum) - A Work-Inefficient Scan Kernel- A Work-Efficient Parallel Scan Kernel					
Module:7	High Speed PCB design and Analysis Wireless Standards	6 hours			
Parallel SpMV Using CSR-Padding and Transposition-Using Hybrid to Control Padding-Sorting and Partitioning for Regularization					
Module:8	Contemporary Issues	2 hours			

	Total Lecture hours:	45 hours	
Text Book(s)			
1.	AnantaGram, Anshul Gupta, George Karypis, Vipin Kumar, Introduction to Parallel Computing, 2011, Second Edition, Addison Wesley Professional, UK.		
2.	David B. Kirk and Wen-mei W. Hwu, Programming Massively Parallel Processors: A Hands-on Approach, 2016, Third Edition, Morgan Kaufmann Publishers, US.		
Reference Books			
1.	Pacheco, Peter. An Introduction to Parallel programming, 2011, First Edition, Morgan Kaufmann Publishers, USA		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS612L	Advanced Embedded Programming	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at:					
<ol style="list-style-type: none"> To learn advanced programming skills of the Embedded C and Linux and the range of embedded applications. To develop skills and understand the embedded Linux device drivers. 					
Course Outcome					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> Develop character driver. Gain knowledge about advanced device driver functions. Comprehend Linux device model Comprehend interrupt handlers in device drivers Debug a device driver code Develop I/O management Develop USB in device driver 					
Module:1	Basic Device driver review	6 hours			
Boot loader, Driver concepts -Block & character driver distinction -Low level drivers, OS driversetc -Writing character drivers - Device major, minor number.					
Module:2	Advanced Device driver characteristics	6 hours			
Interfaces to driver read, write, ioctl etc - Blocking and non-blocking calls, Synchronisation - Semaphores , mutexes ,spinlocks – Proc & Sysfs interfaces					
Module:3	The Linux Device Model	6 hours			
K objects, K sets, and Subsystems, Low-Level Sysfs Operations, Hot plug Event Generation Buses, Devices, and Drivers, Classes, Putting It All Together, Hot plug, Dealing with Firmware					
Module:4	Interrupt Handling	6 hours			
Interrupts and bottom halves -Writing interrupt driven drivers, Implementing bottom halves- Kernel Threads & Work Queues					
Module:5	Time Delays and Debugging Techniques	6 hours			
Timers, Kernel timers, Jiffies , Timer interrupts- Debugging using printing, querying, watching and system defaults-Debugging tools					
Module:6	Communicating with Hardware	6 hours			
I/O Mapped I/O, Memory mapped I/O, Understanding DMA operations.					
Module:7	USB Driver Model	7 hours			
USB Device Basics, USB and Sysfs, USB Urbs, Writing a USB Driver, USB Transfers without Urbs.					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:			45 hours
Text Book(s)					
1.	John Madieu, Linux Device Drivers Development,, 2017, www.packt.com .				
2.	Mohan LalJangir, Linux Kernel and Device Driver Programming, 2014, 1st Edition, University				

	Science Press, India		
Reference Books			
1.	Mastering Embedded Linux Programming, 2017, 2nd Edition, Packt Publishing, UK.		
2.	Derek Molloy, Exploring Beagle Bone: Tools and Techniques for Building with Embedded Linux, 2015, 1st Edition, Wiley Publications, USA.		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS607L	Advanced Processors and its Applications	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at:					
<ol style="list-style-type: none"> 1. Providing a complete understanding of the ARM Cortex architecture. 2. Imparting the knowledge of programming ARM Cortex architecture. 3. Providing knowledge on programmable DSPs Architecture, On-chip Peripherals and Instruction set. 					
Course Outcome					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> 1. Learn the architecture and instruction set of ARM Cortex M4. 2. Program GPIOs and Interrupts of an ARM cortex M4. 3. Develop applications based on Timers, PWM and ADC with ARM cortex M4. 4. Understand and program the various communication modules of ARM Cortex M4. 5. Acquire knowledge about ARM Cortex A architecture. 6. Comprehend programming of ARM 64 bit architecture. 7. Demonstrate their ability to program the DSP processor for signal processing applications. 8. Design application for various social relevant and real time issues. 					
Module:1	ARM architecture and Cortex – M series	4 hours			
Introduction to the ARM Cortex M4 and its targeted applications, ARM Cortex M4 architecture address space, on- chip peripherals (analog and digital) Register sets, addressing modes and instruction set basics.					
Module:2	Microcontroller Programming	6 hours			
ARM Cortex M4: I/O pin multiplexing, pull up/down registers, GPIO control, Memory Mapped Peripherals, programming System registers. Introduction to Interrupts, Interrupt vector table, interrupt programming.					
Module:3	Timers, PWM and Mixed Signals Processing	4 hours			
Timer, Basic Timer, Real Time Clock (RTC), Timing generation and measurements, ADC. PWM Module & Quadrature Encoder Interface (QEI).					
Module:4	Communication protocols and Interfacing with external devices	4 hours			
I2C protocol, SPI protocol, USB & UART protocol. Implementing and programming I2C, SPI, USB & UART interface.					
Module:5	ARM Cortex A Architecture	4 hours			
Introduction to ARMv8-A, ARMv8-A Memory Management, ARMv8-A Memory Model, Caches and Branch Prediction, Synchronization and Cache coherency.					
Module:6	Software Engineers guide to ARM Cortex 64 bit architecture	2 hours			
Bootling, Power Management, Virtualization, Security, Debugging.					
Module:7	DSP Processors	4 hours			
Architecture of TMS320CXX Processor – Addressing modes – Assembly language Instructions – Assembler directives, Pipeline structure, On-chip Peripherals – Block Diagram of DSP starter kit (DSK) – Software Tools, DSK on-board peripherals, – Code Composer Studio – Support Files - Application Programs for processing real time signals.					
Module:8	Contemporary Issues	2 hours			

	Total Lecture hours:	30 hours	
Text Book(s)			
1.	Joseph Yiu, "The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors", 2013, 3rd Edition, Newnes ,UK.		
2.	ARM Cortex-A Series Programmer's Guide for ARMv8-A Version: 1.0, 2015, ARM, United States.		
3.	James A Langbridge, "Professional Embedded ARM Development", 2014,1 st Edition, John Wiley Sons & Inc., United States.		
4.	Jonathan W. Valvono "Introduction to ARM Cortex-M Microcontrollers", 2014, 5 th Edition, Create Space Independent Publishing Platform, United States.		
5.	RulphChassaing and Donald Reay, Digital Signal Processing and Applications with the C6713 and C6416 DSK, John Wiley and Sons, Inc., Publication, 2012 (Reprint).		
Reference Books			
1.	Harris and Harris, Digital Design and Computer Architecture: ARM Edition, 2015, Morgan Kaufmann, , United States.		
2.	Yifeng Zhu, Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C, 2015, 2nd Edition, E-Man Press LLC, United States.		
3.	Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, Cengage Learning India Private Limited, Delhi 2012.		
4.	B. Venkataramani and M. Bhaskar, Digital Signal Processors – Architecture, Programming and Applications – Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MEDS607P	Advanced Processors and its Applications Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed at:					
<ol style="list-style-type: none"> 1. Providing a complete understanding of the ARM Cortex architecture. 2. Imparting the knowledge of programming ARM Cortex architecture. 3. Providing knowledge on programmable DSPs Architecture, On-chip Peripherals and Instruction set. 					
Course Outcome					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> 1. Learn the architecture and instruction set of ARM Cortex M4. 2. Program GPIOs and Interrupts of an ARM cortex M4. 3. Develop applications based on Timers, PWM and ADC with ARM cortex M4. 4. Understand and program the various communication modules of ARM Cortex M4. 5. Acquire knowledge about ARM Cortex A architecture. 6. Demonstrate their ability to program the DSP processor for signal processing applications. 					
Indicative Experiments					
1	Task-1 Explore the GPIO of ARM Microcontroller and perform the basic operations of Blinking LED, Interfacing Switch , Seven Segment Display.				7 hours
2	Task-2 Timer based application. Generating the various waveform. Generate a time delay. Controlling the DC motor using Timer/PWM.				7 hours
3	Task-3: Interfacing sensors using I2C, SPI protocols. Interfacing LCD				8 hours
4	Task-4: Explore the other peripherals of ARM and perform CAN based experiments, Audio processing involving DAC, ADC in to the exercises.				8 hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MEDS696J	Study Oriented Project				02
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
<ol style="list-style-type: none"> 1. The student will be able to analyse and interpret published literature for information pertaining to niche areas. 2. Scrutinize technical literature and arrive at conclusions. 3. Use insight and creativity for a better understanding of the domain of interest. 					
Course Outcome:					
<ol style="list-style-type: none"> 1. Retrieve, analyse, and interpret published literature/books providing information related to niche areas/focused domains. 2. Examine technical literature, resolve ambiguity, and develop conclusions. 3. Synthesize knowledge and use insight and creativity to better understand the domain of interest. 4. Publish the findings in the peer reviewed journals / National / International Conferences. 					
Module Content		(Project duration: One semester)			
This is oriented towards reading published literature or books related to niche areas or focussed domains under the guidance of a faculty.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Report to be submitted, presentation and project reviews – Presentation in the National / International Conference on Science, Engineering Technology.					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MEDS697J	Design Project				02
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
<ol style="list-style-type: none"> 1. Students will be able to design a prototype or process or experiments. 2. Describe and demonstrate the techniques and skills necessary for the project. 3. Acquire knowledge and better understanding of design systems. 					
Course Outcome:					
<ol style="list-style-type: none"> 1. Develop new skills and demonstrate the ability to upgrade a prototype to a design prototype or working model or process or experiments. 2. Utilize the techniques, skills, and modern tools necessary for the project. 3. Synthesize knowledge and use insight and creativity to better understand and improve design systems. 4. Publish the findings in the peer reviewed journals / National / International Conferences. 					
Module Content		(Project duration: One semester)			
Students are expected to develop new skills and demonstrate the ability to develop prototypes to design prototype or working models related to an engineering product or a process.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Report to be submitted, presentation and project reviews – Presentation in the National / International Conference on Science, Engineering Technology.					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MEDS698J	Internship I/ Dissertation I				10
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field and also to give research orientation.					
Course Outcome:					
<ol style="list-style-type: none"> 1. Considerably more in-depth knowledge of the major subject/field of study, including deeper insight into current research and development work. 2. The capability to use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues. 3. A consciousness of the ethical aspects of research and development work. 4. Publications in the peer reviewed journals / International Conferences will be an added advantage. 					
Module Content			(Project duration: one semester)		
<ol style="list-style-type: none"> 1. Dissertation may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities. 2. Dissertation should be individual work. 3. Carried out inside or outside the university, in any relevant industry or research institution. 4. Publications in the peer reviewed journals / International Conferences will be an added advantage. 					
Mode of Evaluation: Assessment on the project - Dissertation report to be submitted, presentation, project reviews and Final Oral Viva Examination.					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MEDS699J	Internship II/ Dissertation II				12
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.					
Course Outcome:					
Upon successful completion of this course students will be able to					
<ol style="list-style-type: none"> 1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints. 2. Perform literature search and / or patent search in the area of interest. 3. Conduct experiments / Design and Analysis / solution iterations and document the results. 4. Perform error analysis / benchmarking / costing. 5. Synthesize the results and arrive at scientific conclusions / products / solution. 6. Document the results in the form of technical report / presentation. 					
Module Content			(Project duration: one semester)		
<ol style="list-style-type: none"> 1. Dissertation may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities. 2. Dissertation should be individual work. 3. Carried out inside or outside the university, in any relevant industry or research institution. 4. Publications in the peer reviewed journals / International Conferences will be an added advantage. 					
Mode of Evaluation: Assessment on the project - Dissertation report to be submitted, presentation, project reviews and Final Oral Viva Examination.					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	