Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

Course Contents (Syllabus) for

Second Year M. Tech
(Electronics Engineering)
Sem. III to IV

AY 2020-21

Semester II

Title of the Course and Course Code :	L	T	P	Cr
Advanced Embedded Programming 4EN521	3	0	0	3

Pre-Requisite Courses: Embedded System Design

Textbooks:

1. The Real-Time Kernel by Micrium
2. Real-time Operating Systems: Book 1 - The Theory (The engineering of real-time embedded systems) by Jim Cooling

   Embedded Systems: Introduction to Arm® Cortex™-M Microcontrollers , Fifth Edition (Volume 1) by Jonathan W Valvano

References: http://www2.keil.com/mdk5/cmsis/

User Guide and Reference Guide of LPC 1768, STM32F7

www.usb.org › Developers › Documents

https://www.segger.com/

Course Objectives :

To illustrate Real Time operating system with multi-tasking
To illustrate task synchronisation of various tasks
To develop student in latest Buses Like USB, Ethernet
To develop student to design GUI Applications

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive Level	Bloom's Cognitive Descriptor
CO1	Apply RTOS concepts and multitasking to embedded systems	Applying	Apply
CO2	Design RTOS based systems with Process Synchronization using semaphore, mutex , flags, messages etc.	Creating	Design
CO3	Explain Advance multi-core processing systems and inter processor communication.	Evaluating	Explain
CO4	Design embedded GUI based system	Creating	Design
CO5	Develop embedded programs with embedded USB port	Creating	Develop

CO6	Create embedded system using various IO peripherals	Creating	Create

CO-PO Mapping :

PO	1	2	3	4	5	6
CO1			2			
CO2				3		
CO3						2
CO4				2		
CO5			2			
CO6	1		2			
3-H, 2-M, 1-L						

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: RTOS Programing	**6 Hrs.**
Need and Requirements of RTOS, Concept of Multitasking, Priority inversion, RTOS structure, TCB block design, Repetitive Timer Requirement, Memory Requirement for each Task	
Module 2 : RTOS Process Synchronization	**6 Hrs.**
System events and interrupts. Task synchronization with Flags, Semaphore, Mutex. Inter process communication with Messages queue/ MailBox	
Module 3 : Multi core processors	**6 Hrs.**
Programming on Multi core processors, inter-core communication, interrupt handling, software architecture for multi core processors.	
Module 4: GUI Programming	**6 Hrs.**
Graphical Display Interface, Touch Screen Interface, Graphic Display drivers, GUI API calls for Windows, Dialogs programming, Designing Menu, Widgets programing for Textbox, Label, Combo box etc. Designing Application with GUI	
Module 5: USB Programming	**6 Hrs.**
USB 2.0 specifications, USB block diagram, Device , Host Interface, concept of endpoint, Data transfer on USB bus, Various USB data transfers, API for USB Host and Device Programming, Writing Application with USB Host and Device	
Module 6 : Ethernet Programming & Embedded Application	**6 Hrs.**

Motivation, Ethernet Interface , API for Ethernet Programming, Writing Server Application with Ethernet interface. Designing Server Application with GUI	

Module wise Measurable Students Learning Outcomes : Students will able to

Module 1: Apply RTOS concepts and multitasking to embedded system

Module 2: Design RTOS based embedded system with Process Synchronization using semaphore, mutex, flags, messages etc.

Module 3: Design embedded system with Advance peripherals like USB, Graphics displays, Ethernet etc.

Module 4: Design GUI based system

Module 5: Develop programs with USB port

Module 6: Design embedded system applications using various peripherals

Title of the Course and Course Code:	**L**	**T**	**P**	**Cr**
Advanced Communication Networks and IoT 4EN522	3	0	0	3

Pre-Requisite Courses: Data Communication and Networking

Textbooks:

1. D.E. Comer *"Internetworking with TCP/IP*", Vol. I (4th Edition), II, III (PHI)
2. *"Internet of Things Applications and Protocols ", Wiely publication 2nd Ed.*
3. William Stallings "*Foundations of Modern Networking : SDN, NFV, QoE, IoT and Cloud"* Pearson Education

References:

1. Richard Steven "*UNIX Network Programming: III Edition*", , PHI
2. Stevens, Gabrani *" TCP/ IP illustrated Vol1, 2*" PEARSON
3. Leon-Garcia, Widjaja, "Communication Networks", TMH.

Course Objectives :

1. To provide understanding of the networking concepts and widely used protocol suite TCP/IP in detail
2. To demonstrate Policy, Procedure and Managerial approach towards a required Network design and application program.
3. To expose the student with the latest trends & techniques in the field and expertise him/her considering academic & professional aspect**.**

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	**Descriptor**
CO1	Explain in a concise manner how the general Internet as well as Internet of Things work.	Understanding, Analysing	Explain, Identify
CO2	Design prototype to demonstrate Internet of Thing application with constraints and opportunities of network.	Creating	Design
CO3	Apply the knowledge for solution building	Applying	Demonstrate, Apply

CO-PO Mapping :

PO	1	2	3	4	5	6
CO1			3			
CO2				3		
CO3	2					
3-H, 2-M, 1-L						

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Course Contents:

Module 1 Introduction to Internet Technology	**Hrs.**
Internet addresses, ARP, RARP, Tools of Internet access and addressing , Routing Features of Ipv6, General form of an Ipv6 address types, Proposed Ipv6 address space, ICMP.	**6**
Module 2 Transport Layer TCP	**Hrs.**
UDP, TCP, TCP state diagram, Flow, Error Congestion Control in TCP, TCP Timers, Kern's algorithm, UDP TCP Socket	**7**
Module 3 Internet Applications and Protocols	**Hrs.**
Real time transport protocol (RTP), RSVP, Encapsulation, Session Control Protocols DNS techniques DNS: Names for machines, Remote Login: Remote Interactive computing, TELNET protocol, FTP: File access and transfer, Online shared access, sharing by file transfer, SMTP, Electronic Mail, Standards for Services.	**6**
Module 4 Internet Security	**Hrs.**
Firewall, mechanisms for internet security, A firewall, the details of firewall architecture, Types of fire walls, IPSec, VPN.	**6**
Module 5 IoT	**Hrs.**
IoT definitions: overview, applications, potential & challenges, and architecture. M2M Protocols for Sensor Networks. IoT CASE Study.	**6**
Module 6 Cloud and SDN	**Hrs.**
Introduction to Cloud Computing including benefits, challenges, and risks Cloud Computing Models. SDN: Introduce software defined networking: the background, the development, and the challenges.	**7**

Module wise Measurable Students Learning Outcomes :

Module 1: Demonstrate basic IoT concept
Module 2: Analyse TCP/IP protocol
Module 3: Analyse the Application layer protocols and applications
Module 4: Illustrate different security issues and mitigation technique
Module 5 : Design prototype IOT system
Module 6: Explain advanced systems and overview of IoT from design and analysis prospective.

Title of the Course and Course Code:	**L**	**T**	**P**	**Cr**
Electronics Lab 3 4EN571	0	0	4	2

Pre-Requisite Courses: Embedded System Design

Textbooks:

3. The Real-Time Kernel by Micrium
4. Real-time Operating Systems: Book 1 - The Theory (The engineering of real-time embedded systems) by Jim Cooling

Embedded Systems: Introduction to Arm® Cortex™-M Microcontrollers , Fifth Edition (Volume 1) by Jonathan W Valvano

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Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive Level	Bloom's Cognitive Descriptor
CO1	Apply RTOS concepts and multitasking to embedded systems	Applying	Apply
CO2	Design RTOS based systems with Process Synchronization using semaphore, mutex , flags, messages etc.	Creating	Design
CO3	Explain Advance multi-core processing systems and inter processor communication.	Evaluating	Explain
CO4	Design embedded GUI based system	Creating	Design
CO5	Develop embedded programs with embedded USB port	Creating	Develop
CO6	Create embedded system using various IO peripherals	Creating	Create

CO-PO Mapping :

PO	1	2	3	4	5	6
CO1			2			
CO2				2		
CO3				2		
CO4	2					
3-H, 2-M, 1-L						

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Module wise Measurable Students Learning Outcomes : Students will able to create and demonstrate programs for

Module 1: RTOS multitasking for embedded system

Module 2: Process Synchronization using semaphore, mutex, flags, messages etc.

Module 3: Designing GUI based system

Module 4: Ethernet peripherals

Module 5: USB Host Controller port

Module 6: USB device port

Module 7: Camera interface peripherals

Module 8: Design embedded system applications using GUI

Title of the Course and Course Code:	**L**	**T**	**P**	**Cr**
Industrial Project Lab 4EN572	0	0	4	2

Course Objectives :

1.To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques.

2. To Identify, understand and discuss current, real-world issues, new technologies, research, products, algorithms etc.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive Level	Bloom's Cognitive Descriptor
CO1	To use multiple thinking strategies to examine real-world issues and explore creative possibilities of expression	Analyzing	Identify, Examine
CO2	To acquire, articulate, create and convey intended meaning using verbal and nonverbal method of communication	Creating	Produce, Create
CO3	To learn and integrate, through independent learning in technologies, with disciplinary specialization in Electronics Engineering	Creating	Develop, Organize, Prepare

CO-PO Mapping :

PO	1	2	3	4	5	6
CO1				3		
CO2			3			
CO3						2
3-H, 2-M, 1-L						

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Course Contents:

The student shall have to deliver the seminar on a topic approved by guide and authorities. It is recommended that seminar shall be on the topic relevant to state-of-the-art trends in the field of Electronics Engineering, preferably on the topic of specialization based on the electives selected or domain of interest.

It is appreciated and strongly recommended that the student will select the domain of his/her dissertation and identify the literature confined to the domain. Thorough literature study based on the broad identified topic has to be carried out. This preparation will ultimately lead to convergence of the efforts for the dissertation work to be completed in Semester III and IV.

The relevant literature then be explored as high-tech, exotic, recent technological advancements, future trends, applications and research & innovations. Multidisciplinary topics are encouraged. The student shall submit the duly approved and certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department. The student will be assessed based on his/her presentation and preparations by the panel of examiners in the department.

Title of the Course and Course Code :	**L**	**T**	**P**	**Cr**
Professional Elective 3: RTL Simulation and Synthesis with PLDs 4EN531	3	0	0	3

Pre-Requisite Course: Digital Design Principles

Textbooks:

1. *"Richard Sandige,: Modern Digital Design \, MGH, International Edition*
2. *"Donald D. Givone, "Digital Principles and Design", TMH*
3. *Charles Roth, Jr Lizy K John, "Digital System Design using VHDL", Cengage*

References:

1. *"Xilinx Simulation and Synthesis Guide" www://Xilinx.com*
2. *Net material on simulation and synthesis from Xilinx, Altera, etc*

Course Objectives:

1. Explain the concepts of HDL simulation and synthesis
2. Illustrate with examples good ways of writing synthesizable HDL code
3. Guide the students to explore various FPGA architectures and compare those
4. Explain the concepts of testing and testability
5. Facilitate students to develop their own IP for a given problem and use in typical application.

Course Learning Outcomes:

At the end of the course student will be able to

CO1: Model and write synthesizable code for digital circuits using VHDL/Verilog

CO2: Justify FPGA architecture for a specific vendor

CO3: Explain the design flow and design combinational and sequential circuits using FPGA technology
CO4: Differentiate between functional and timing simulation
CO5: Design the digital systems with built-in testability aspect
CO6: Design prototypes and IPs for given problem.

CO-PO Mapping :

PO	1	2	3	4	5	6
CO1			2			
CO2			2			
CO3				2		
CO4			2			
CO5	3					
CO6	3					
3-H, 2-M, 1-L						

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

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Course Contents:

Module Details	Hrs
Module 1: Top Down approach to design digital systems, FPGA design flow, Design of FSMs and ASMs, Clock issues, Metastability, Multi-clock domain designs (CO1,	**6**
Module 2: RTL code design entry using VHDL/Verilog and correct design hierarchy, VHDL Simulation, Functional simulation, (CO1, CO4)	**6**
Module 3: Generics and constants, Data path designs, FSM design styles, Designing memories, Designing arithmetic blocks, VHDL/Verilog Attributes (CO3)	**8**
Module 4: Programmable Logic Devices, FPGA Architecture, VHDL Synthesis, timing simulation, Static timing analysis, Placement (floor planning), Clock tree synthesis, Routing, Downloading synthesized, placed and routed designs in FPGAs (CO2)	**8**
Module 5: Design for performance, Timing problems root causes, set-up and hold time violations, Defining constraints, Low power VLSI designs, Design for testability (CO5)	**6**
Module 6: IP and Prototyping**:** Implementing IPs for designing complex digital circuits, Speed issues and few case studies (CO6)	**6**

Module wise Measurable Students Learning Outcomes :

Module 1: CO1
Module 2: CO1, CO4

Module 3: CO3,
Module 4: CO2
Module 5: CO5
Module 6: CO6

Title of the Course and Course Code	L	T	P	Cr
Professional Elective 3 : Pattern Recognition and Image Analysis 4EN532	3	0	0	3

Pre-Requisite Courses: Signal Processing, Image Processing

Textbooks:

1. Earl Gose and Richard Johnsonbaugh Steve Jost, "Pattern Recognition and Image Analysis", PHI publication.
2. Sing Tze Bow, M. Dekker, "Pattern Recognition and Image Processing", Springer, 1992

References:

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Addinson – Wesley.
2. M. A. SID – AHMED, "Image Processing Theory Algorithms and Architecture", McGraw Hill Inc.

Course Objectives :

To be familiar with processing of images, recognition of the pattern and their applications.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive Level	Bloom's Cognitive Descriptor
CO 1	Contrast different image processing operations for improving image quality through enhancement, restoration and filtering etc..	Understanding	Contrast
CO 2	Categorize Image segmentation for partitioning into objects and background	Analysing	Categorize
CO 3	Analyse extraction of image features, quantifying shapes, pattern recognition, image analysis	Analysing	Analyse

CO-PO Mapping :

PO	1	2	3	4	5	6
CO1			2			
CO2				2		
CO3			2			
3-H, 2-M, 1-L						

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

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ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Module wise Measurable Students Learning Outcomes :

students are able to

Module 1: Compare basic of pre-processing algorithm

Module 2: Experiment with the segmentation on various images

Module 3: Choose morphological filters for various application

Module 4: Distinguish various texture in an image

Module 5: Identify various pattern in an image

Module 6: Classify pattern in an image

Title of the Course and Course Code:	L	T	P	Cr
Professional Elective 4: Wireless Sensor Networks 4EN535	3	0	0	3

Pre-Requisite Courses: Fundamentals of networking.

Textbooks:

1. Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks Technology Protocols and Applications", John Wiley & Sons Inc. Publication ,2007

References:

1.Edgar H. Callaway, Jr. and Edgar H. Callaway, "Wireless Sensor Networks: Architectures and Protocols" ,CRC Press, August 2003
2. Ian F. Akyildiz, Mehmet Can Vuran**,"**Wireless Sensor Networks" ,John Wiley & Sons Ltd. 2010

Course Objectives :

1.To explain the Wireless Sensor Network and its applications
2.To distinguish working principles of various WSN protocols
3.To discuss security issues of WSN and its performance

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive Level	Bloom's Cognitive Descriptor
CO1	Analyse Prototypes for Wireless Sensor Network	Analyzing	Distinguish
CO2	Calculate performance issues in Wireless Sensor Network	Evaluating	Justify
CO3	Analyse different layer protocols and security issues of Wireless Sensor Network	Analyzing	Identify

CO-PO Mapping :

PO	1	2	3	4	5	6
CO1				3		
CO2			3			
CO3				2		
3-H, 2-M, 1-L						

Assessment:

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ISE 1	10
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Course Contents:

Module 1 :Introduction and Overview of Wireless Sensor Networks	**Hrs.**
Introduction to wireless Ad-hoc network , Mobile Ad-hoc Network and Overview of Wireless Sensor Networks, Applications of Wireless Sensor Networks	**5**
Module 2:Wireless Transmission Technology and Medium Access Control Protocols	**Hrs.**
Basic Wireless Sensor Technology, Sensor Node Technology, Hardware and Software, Sensor Taxonomy, WN Operating environment, WN Trends, Wireless Transmission Technology and Systems, Medium Access Control Protocols for Wireless Sensor Networks, Fundamentals of MAC Protocols, MAC Protocols for WSNs.	**7**
Module 3: Routing Protocols and Transport Control Protocols for Wireless Sensor Networks	**Hrs.**
Routing Challenges and Design Issues in Wireless Sensor Networks, Routing Protocols for Wireless Sensor Networks, -Data Dissemination and Gathering, , Routing Strategies in Wireless Sensor Networks, Transport Control Protocols for Wireless Sensor Networks, Traditional Transport Control Protocols, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols, Performance of Transport Control Protocols	**9**
Module 4: Middleware and Network Management for WSN	**Hrs.**
WSN Middleware Principles- Middleware Architecture, Existing Middleware, Network Management for Wireless Sensor Networks Operating Systems for Wireless Sensor Networks- Operating System Design Issues, Examples of Operating Systems-TinyOS	**7**
Module 5: Security Issues	**Hrs.**
WSN security issues, Possible attacks on WSN, worm hole, black hole , sync attack and effect on performance, mitigation techniques	**6**
Module 6: Performance and Traffic Management	**Hrs.**
Performance and Traffic Management- Introduction, Background, WSN Design Issues, Performance Modelling of WSNs, Performance Metrics, Basic Models, Network Models	**5**

Module wise Measurable Students Learning Outcomes :

Module 1: Distinguish different types of ad hoc networks and its applications

Module 2: i)Analyze wireless sensor node components , transmission impairments and performance issues like power, Energy, distance between wireless nodes

ii)Analysis of MAC protocols

Module 3: i)Distinguish Routing protocols and Transport control protocol for WSN

Module 4: i)Describe of middleware and network management protocols

ii)Design issues of OS for WSN

Module 5: Identify different security issues of WSN

Module 6: Analyse Different models of WSN and its performance analysis.

Title of the Course and Course Code:	L	T	P	Cr
Program Elective 4: System On Chip 4EN536	3	0	0	3

Pre-Requisite Courses: Microprocessor / Microcontrollers

Textbooks:1. Michael J Flynn and Wayne Luk, ―Computer system Design: System-on-Chip‖, Wiley-India, 2012.
2. SudeepPasricha and NikilDutt, ―On Chip Communication Architectures: System on Chip Interconnect‖, Morghan Kaufmann Publishers, 2008.
3.Lin, Y-L S (ed.), ―Essential Issues in SOC Design: Designing Complex Systems-on-chip. Springer, 2006.

References: 1. Wolf W H, ―Computers as Components: Principles of Embedded Computing System Design‖, Elsevier, 2008.
2. Patrick Schaumont ―A Practical Introduction to Hardware/Software Co-design‖, Patrick Schaumont, Springer, 2012.
3. Lin, Y-L S (ed.), ―Essential Issues in SOC Design: Designing Complex Systems-on-chip. Springer, 2006. 6. Wayne Wolf, ―Modern VLSI Design: IP Based Design‖, Prentice-Hall India, 2009.
4. Amba bus architecture at http://www.arm.com/products/solutions/Ambahomepage.html

Course Objectives :
1. To make students aware of the system on chip concepts
2. To make students learn the Bus interconnect hardware Design approach
3. To make students learn the IP design
4. To make students learn Model-based system design
5. To make students learn hardware software co-design approach

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive Level	Descript
CO1	Illustrate the concepts of system on chip.	Illustrating	Illustrate
CO2	Design approach using interconnect bus like AMBA for SoC technology 3. They will be able to design IP using EDA Tools	Creating	Design
CO3	Design IPs using EDA Tools	Creating	Design
CO4	Design SoC for given specifications and implement using EDA Tools.	Creating	Design
CO5	Discuss the test strategy, write the test benches and test the designed SoC for functionality and performance using EDA	Creating	Discuss, Test

CO-PO Mapping :

PO	1	2	3	4	5	6
CO1			2			
CO2						1
CO3				2		
CO4						2
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Course Contents:

Module 1	**4**
INTRODUCTION TO THE CONCEPT OF SoC: Differences between Embedded systems and SOCs ,Driving Forces for SoC - Components of SoC - Design flow of SoC - Hardware/Software nature of SoC - Design Trade-offs - SoC Applications.	
Module 2	**6**
SYSTEM-LEVEL DESIGN: Processor selection-Concepts in Processor Architecture: Instruction set architecture (ISA), elements in Instruction Handing-Robust processors: Vector processor, VLIW, Superscalar, CISC, RISC—Processor evolution: Soft and Firm processors, Custom Designed processors- on-chip memory.	
Module 3	**8**
SYSTEM-LEVEL INTERCONNECTION: On-chip Buses: basic architecture, topologies, arbitration and protocols, Bus standards: AMBA, Wishbone, Avalon. Network-on-chip: Architecture-topologies-switching strategies - routing algorithms - flow control, Quality-of-Service Re-Configurability in communication architectures.	
Module 4	**6**
IP BASED SYSTEM DESIGN: Introduction to IP Based design, Types of IP, IP across design hierarchy, IP life cycle, Creating and using IP - Technical concerns on IP reuse - IP integration - IP evaluation on FPGA prototypes.	
Module 5	**6**
SOC IMPLEMENTATION: Study of processor IP, Memory IP, wrapper Design - Real-time operating system (RTOS), Peripheral interface and components, High-density FPGAs, EDA tools from Xilinx and Intel for SoC design.	

Module 6	6
SOC TESTING: Manufacturing test of SoC: Core layer, System layer, Application layer- P1500 Wrapper Standardization-SoC Test Automation (STAT).	

Module wise Measurable Students Learning Outcomes : students will

Module 1: Illustrate the SOC hardware Design approach
Module 2: Discuss various CPU architectures
Module 3: Illustrate interconnect buses
Module 4: Design Model-based SoC system with EDA tool
Module 5: Design hardware software based SOC system with EDA tool
Module 6: Develop and test SoC with sample software programs using EDA tool

Title of the Course and Course code : Electronics Lab 4 4EN573	L	T	P	Cr
	0	0	4	2

Pre-Requisite Courses: Digital design, Signal processing

Text Books: Related to respective Program Elective 2 courses

Reference Books: Related to respective Program Elective 2 courses

Course Objectives :

1. To develop student's technical skill in the course which he has chosen as Program Elective 1
2. To prepare the students for their dissertation work by assigning them mini projects

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive Level	Bloom's Cognitive Descriptor
CO1	Choose and collect required data, find solution , develop mathematical /simulation model for given assignment	Analysing	Construct, Compare
CO2	Write programs using appropriate software tool for given assignment	Creating	Propose, formulate
CO3	Develop an ability to work independently for open ended research (Dissertation) work	Creating	Design

CO-PO Mapping :

PO	1	2	3	4	5	6
CO1			2			
CO2				2		
CO3	2					
3-H, 2-M, 1-L						

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Semester III

Title of the Course and Course Code:	**L**	**T**	**P**	**Cr**
Dissertation Phase I 3EN690	0	0	8	4

Course Objectives :

1. To identify the domain of research
2. To recognize the various means of technical publications and terminologies associated with publications
3. To categorize the research material related to the domain of choice
4. To formulate and articulate research problem with the help of the guide elaborating the research.
5. To obtain information independently and assessing its relevance for answering the research questions

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive Level	Bloom's Cognitive Descriptor
CO1	Conduct in-depth literature survey confined to the domain of dissertation work	Analyzing	Identify, Examine
CO2	Develop presentation skills to deliver the technical contents obtained through literature survey	Creating	Produce, Create
CO3	Prepare Synopsis/ Outline of dissertation work	Creating	Develop, Organize, Prepare
CO4	Analyze the findings and work of various authors in the area of the dissertation work	Analyzing	Analyze,

CO-PO Mapping :

PO	1	2	3	4	5	6
CO1	3					
CO2		3				
CO3		2				
CO4				2		
3-H, 2-M, 1-L						

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.

Title of the Course and Course Code:	L	T	P	Cr
Dissertation Phase II 3EN691, 3EN692	0	0	12	6

Course Objectives :

1. To follow methodology precisely and meet the objectives of proposed work
2. To test rigorously before deployment of system
3. To validate the work undertaken

4. To consolidate the work as furnished report

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	**Descriptor**
CO1	Demonstration evidence of independent investigation	Understanding	Explain
CO2	Critically analyze the results and their interpretation; infer findings	Analyzing	Compare, Classify
CO3	Prepare a report and present the original results in an systematic way	Creating	Write, Compose
CO4	Interpret practical inferences and limitations of the subject that he/ she has chosen for dissertation work	Understanding	Summarize

CO-PO Mapping :

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1	3					
CO2		3				
CO3		2				
CO4				2		
3-H, 2-M, 1-L						

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.

Course Contents:

In Dissertation Phase–II, the student shall consolidate and complete the remaining part of the dissertation work in the field of Electronics Engineering which will consist of implementation of devised algorithm/ system using simulation tool and/or selected hardware, testing, results, measuring performance, comparative analysis, validation of results and conclusions.

The student shall prepare the duly certified final report of Dissertation in standard format for satisfactory completion of the work by the concerned guide and head of the Department.

The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal.

The student will be assessed by a panel of examiners in the department for ISE 1 and ISE 2. In ESE there will be one external examiner, internal examiner/guide and a chairman for assessment. The assessment will be broadly based on literature study, work undergone, content delivery, presentation skills, documentation and report.

Title of the Course and Course Code: Professional Elective 5 **Artificial Intelligence 3EN611**	**L**	**T**	**P**	**Cr**
	3	0	0	3

Pre-Requisite Courses: Programming Knowledge

Textbooks:

1. Mariusz Flasiński, Introduction to Artificial Intelligence, Springer, 1st edition, 2016
2. Stuart Russell and Peter Norvig, Artificial Intelligence – A Modern Approach, Prentice Hall Series, Third Edition 2010
3. Michael Negnevitsky, Artificial Intelligence- A guide to intelligent systems, Pearson Education, second edition, 2005

References:

1. N J Nilsson,Morgan, Principles of Artificial Intelligence, Kaufmann Publishers Inc. San Francisco, CA, USA, 1980

2. Elaine Rich, Kevin Knight, Shivashankar B Nair, Artificial Intelligenc, , Tata McGraw Hill Publishing Company Limited, Third edition 2009

Course Objectives :

1. To introduce foundation of Artificial Intelligence and Neural network
2. To introduce knowledge of Expert systems, artificial neural networks, fuzzy systems and evolutionary computation technologies
3. To articulate logic of various Search methods, Heuristic Search methods, Pattern recognition and cluster analysis
4. To introduce tools supporting these technologies

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**

		Level	Descriptor
CO1	Articulate principles behind intelligent systems, knowledge of Expert systems, artificial neural networks, fuzzy systems and evolutionary computation etc.	Understanding	Describe
CO2	Implement Search algorithms, Pattern recognition and cluster analysis	Applying	Demonstrate
CO3	Develop small rule-based and frame-based expert systems, explore artificial neural networks, and implement a simple problem as a genetic algorithm.	Analysing	Construct
CO4	Use of MATLAB Neural Network Toolbox	Applying	Execute

CO-PO Mapping :

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			2			
CO2				2		
CO3	2					
CO4				1		
3-H, 2-M, 1-L						

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
Introduction: What is AI, Foundation of artificial intelligence, history of artificial intelligence, Symbolic Artificial Intelligence, Computational Intelligence	**6**
Module 2	**Hrs.**
Expert Systems: Rule based expert systems, Fuzzy expert systems, Frame based expert systems	**7**
Module 3	**Hrs.**
Search Methods: State Space and Search Tree, Blind Search, Heuristic Search, Adversarial Search, Search for Constraint Satisfaction Problems, Special Methods of Heuristic Search.	**7**
Module 4	**Hrs.**
Evolutionary computing: Simulation of natural evolution, Genetic Algorithms, Evolution Strategies, Evolutionary Programming, Genetic Programming, Other Biology-Inspired Models	**6**
Module 5	**Hrs.**

Pattern Recognition and Cluster Analysis, Problem of Pattern Recognition, Minimum Distance Classifier, Nearest Neighbor Method, Decision-Boundary-Based Classifiers, Statistical Pattern Recognition, Decision Tree Classifier, Cluster Analysis	**7**
Module 6	**Hrs.**
Artificial Neural Networks: Introduction, how the brain works ,The neuron as a simple computing element, The perceptron, Multilayer neural networks, Accelerated learning in multilayer neural networks, The Hopfield network, Bidirectional associative memory, Self-organising neural networks	**7**

Module wise Measurable Students Learning Outcomes :

Module 1: Describe principles behind intelligent systems, knowledge of artificial neural networks.
Module 2: Develop small rule-based expert systems and implement a simple problem as a genetic algorithm.
Module 3: Implement Search algorithms such as Blind Search, Heuristic Search, Adversarial Search etc.
Module 4: Catch knowledge of evolutionary computation
Module 5: Implement Pattern recognition and cluster analysis
Module 6: Explore artificial neural networks and implement a simple problem using various learning rules

Title of the Course and Course Code: Professional Elective 5	**L**	**T**	**P**	**Cr**
Automotive Electronics 3EN612	3	0	0	3

Pre-Requisite Courses:

Textbooks:

1. **Bosch Automotive Electrics and Automotive Electronics by Robert Bosch**

4. **References:** https://elearning.vector.com/vl_can_introduction_en.html
5. https://www.nxp.com/docs/en/reference-manual/BCANPSV2.pdf
6. http://www.analog.com/media/en/technical-documentation/application-notes/AN-1123.pdf
7. https://www.autosar.org/
8. https://elearning.vector.com/vl_autosar_introduction_en.html
9. https://www.kpit.com/resources/downloads/kpit-autosar-handbook.pdf
10. https://www.autosar.org/fileadmin/user_upload/standards/classic/3-2/AUTOSAR_Glossary.pdf
11. https://www.autosar.org/fileadmin/user_upload/standards/classic/3-2/AUTOSAR_LayeredSoftwareArchitecture.pdf
12. https://www.autosar.org/fileadmin/user_upload/standards/classic/3-0/AUTOSAR_TechnicalOverview.pdf

Course Objectives :

1. Overview of Automotive electronics system and its components.
2. Automotive sensor and actuator software modules.
3. CAN J1939 protocol
4. AUTOSAR technical overview

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descript
CO1	Illustrate significance of AUTOMOTIVE Electronics	Understanding	Illustrate
CO2	Develop automotive subsystems, Interfaces for automotive sensors and actuators software modules as closed loop	Applying	Develop
CO3	Develop Communication between various controllers using CAN bus and others buses	Applying	Develop
CO4	Explain the AUTOSAR layered architecture	Understanding	Explain
CO5	Develop Model based automotive system using MATLAB	Creating	Develop
CO6	Illustrate automotive systems for EMC complaint	Understanding	Illustrate

CO-PO Mapping :

PO	1	2	3	4	5	6
CO1			2			
CO2				2		
CO3			2			
CO4				1		

CO5			1			
CO6				2		
3-H, 2-M, 1-L						

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 : Overview of Automotive electronics system and its components	**4**
Automotive Market: On road vehicle, off road vehicle, safety and connectivity Hardware :ECU-ICs, PCB, Sensors, Actuators Software: Boot Loader, OS + Application, Calibration parameters. Battery charging system, Engine control system, Steering control system, Automatic transmission system, Cruise control system.	
Module 2: Automotive sensor and actuator software modules	**8**
Sensor: Temperature, Air Mass sensor, Pressure sensor, Speed sensors, Knocking Sensor, Lamda (Oxygen) Sensor, Throttle Position sensor, Cam sensor, Crank position sensor. Physical Sensor Connection, Sensor environment, Harness, Reference voltage, closed loop sensor software module, Calibration, OORH, OORL, In Range, Auto and Manual mode. Actuator: Physical actuator, Actuator driver faults, shorted to Low, Shorted to High, Open circuit. Check to give ON/OFF commands. Failure Mode Identification.	
Module 3 :: Communication protocol	**6**
CAN Bus, CAN J1939 Protocol, LIN Bus ,Flex ray, Automotive Ethernet, RF, Bluetooth, WiFi, Diagnostic Protocol: UDS, Inter-ECU communication protocol, Inter vehicle communication to form autonomous vehicle system Tools: CANoe, Vehicle spy, CAPEL,TAE scripting	
Module 4: Software Architecture	**6**
Classical architecture, Layered architecture (AUTOSAR), Increased E/E complexity, AUTOSAR organization, All layer information(e.g. RTE,BSW, applications) Tools: Davinci developer, configurator, Raphsody	
Module 5: Model based Development:	**8**
Algorithm/application development using Simulink, Stateflow, Code generation for various control algorithms like ESP,ABS, TCS etc.	

Module 6: Electromagnetic Compatibility	4
Introduction to various regulatory requirements and international electrical and EMC standards, Understanding origin of pulses, disturbances, circuit and PCB layout design techniques to meet EMC.	

Module wise Measurable Students Learning Outcomes : student will

Module 1: describe "AUTOMOTIVE Electronics system"

Module 2: Develop automotive subsystems and Interfaces for automotive sensors and actuators

Module 3: Develop Communication between various controllers

Module 4: Explain the AUTOSAR layered architecture in automotive electronics

Module 5: Develop Model based automotive system using MATLAB

Module 6: Explain EMC compliance of automotive systems

Title of the Course and Course Code: **Professional Elective 5**

Introduction to Machine Learning 3EN613

L	T	P	Cr
3	0	0	3

Pre-Requisite Courses: probability & statistics

Textbooks:

1. Tom Mitchell, "Machine Learning" First Edition, McGraw- Hill, 1997.
2. Ethem Alpaydin, "Introduction to machine learning", 2nd edition, The MIT Press

References:

1. Alex Smola and S.V.N. Vishwanathan, "Introduction to Machine Learning", Cambridge University Press 2008.
2. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

Course Objectives :

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Apply knowledge of computing and mathematics to machine learning problems, models and algorithms	Applying	Apply
CO2	Analyse a problem and identify the computing requirements appropriate for its solution	Analyzing	Analyse
CO3	Design, implement, and evaluate an algorithm to meet desired needs	creating	Design

CO-PO Mapping :

PO	1	2	3	4	5	6
CO1			2			
CO2				2		
CO3	2					
3-H, 2-M, 1-L						

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Machine Learning	**Hrs.**
Introduction, Supervised Learning, Learning a Class from Examples, Learning Multiple Classes, Regression, Dimensions of a Supervised Machine Learning Algorithm, Bayesian Decision Theory, Discriminant Functions, Association Rules	**6**
Module 2: Parametric, Multivariate and Nonparametric Methods	**Hrs.**
Maximum Likelihood Estimation, Evaluating an Estimator: Bias and Variance, The Bayes' Estimator, Parametric Classification, Multivariate Data, Multivariate Normal Distribution, Multivariate Classification, Multivariate Regression, Nonparametric Density Estimation, Nonparametric Classification, Nonparametric Regression: Smoothing Models	**6**
Module 3 Dimensionality Reduction**,** Clustering and Decision Trees	**Hrs.**
Principal Components Analysis, Factor Analysis, Linear Discriminant Analysis, Locally Linear Embedding, Mixture Densities, k-Means Clustering, Expectation-Maximization Algorithm, Supervised Learning after Clustering, Hierarchical Clustering, Univariate Trees, Rule Extraction from Trees, Learning Rules from Data, Multivariate Trees	**8**
Module 4 Linear Discrimination and Multilayer Perceptrons	**Hrs.**
Generalizing the Linear Model, Geometry of the Linear Discriminant, Parametric Discrimination Revisited, Gradient Descent, Logistic Discrimination, Discrimination by	**6**

Regression, The Perceptron, Training a Perceptron, Learning Boolean Functions, Multilayer Perceptrons, Backpropagation Algorithm, Training Procedures, Bayesian View of Learning, Dimensionality Reduction, Learning Time	
Module 5 Kernel Machines and Bayesian Estimation	**Hrs.**
Optimal Separating Hyperplane, The Nonseparable Case: Soft Margin Hyperplane, ν-SVM, Kernel Trick, Vectorial Kernels, Multiple Kernel Learning, Multiclass Kernel Machines, Kernel Machines for Regression, Estimating the Parameter of a Distribution, Bayesian Estimation of the Parameters of a Function, Gaussian Processes	**6**
Module 6 Hidden Markov Models and Graphical Models	**Hrs.**
Discrete Markov Processes, Hidden Markov Models, Three Basic Problems of HMMs, Evaluation Problem, Finding the State Sequence, Learning Model Parameters, Model Selection in HMM, Canonical Cases for Conditional Independence, Example Graphical Models, d-Separation, Belief Propagation, Undirected Graphs: Markov Random Fields, Learning the Structure of a Graphical Model, Influence Diagrams	**8**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

Module 1: Relate the basic concepts and methods of machine learning.

Module 2: Classify estimation technique

Module 3: Contrast classification using clustering technique

Module 4: Choose training and back propagation algorithm for classification

Module 5: Distinguish kernel machines for regression

Module 6: Evaluate Hidden Markov model for learning and classification

Title of the Course and Course Code: Professional Elective 5	**L**	**T**	**P**	**Cr**
DSP Architecture 3EN614	3	0	0	3

Pre-Requisite Courses: Digital signal processing

Textbooks:

1. Rohit Chandra, Ramesh Menon, Leo Dagum, David Kohr, DrorMaydan, Jeff McDonald,"Parallel Programming in OpenMP", 1st Edition, Morgan Kaufman,2000.
2. Ann Melnichuk,Long Talk, "Multicore Embedded systems", 1st Edition, CRC Press,2010.
3. Wayne Wolf, "High Performance Embedded Computing: Architectures, Applications and Methodologies", 1st Edition, Morgan Kaufman, 2006.

References:

1. M. Sasikumar, D. Shikhare, Ravi Prakash, "Introduction to Parallel Processing", 1st Edition, PHI, 2006.
2. Fayez Gebali, "Algorithms and Parallel Computing",1st Edition, John Wiley & Sons, 2011
3. E.S.Gopi, "Algorithmic Collections for Digital Signal Processing Applications Using MATLAB", 1st Edition, Springer Netherlands,2007.
4. Website ti.com

Course Objectives :

1. Identify and formalize architectural level characterization of P-DSP hardware
2. Ability to design, programming (assembly and C), and testing code using Code Composer Studio environment
3. Deployment of DSP hardware for Control, Audio and Video Signal processing applications
4. Understanding of major areas and challenges in DSP based embedded systems

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descripto**
CO1	Illustrate the DSP hardware architecture	Illustrating	Illustrate
CO2	Illustrate Multicore DSP processors	Illustrating	Illustrate
CO3	Develop applications using assembly and C with DSP processors	Creating	Develop
CO4	Develop FPGA based DSP systems	Creating	Develop
CO5	Create High Performance Computing systems using P-DSP	Illustrating	Illustrate

CO-PO Mapping :

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			2			
CO2				2		
CO3	2					
CO4	1					
CO5			2			
3-H, 2-M, 1-L						

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

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MSE	30
ISE 2	10
ESE	50

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MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 : Programmable DSP Hardware	**4**
Processing Architectures (von Neumann, Harvard), DSP core algorithms (FIR, IIR, Convolution, Correlation, FFT), IEEE standard for Fixed and Floating Point Computations, Special Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking.	
Module 2: Structural and Architectural Considerations	**8**
Parallelism in DSP processing, Texas Instruments TMS320 Digital Signal Processor Families, Fixed Point TI DSP Processors: TMS320C5414 Family, Internal Architecture, Arithmetic and Logic Unit, Auxiliary Registers, Addressing Modes (Immediate, Direct and Indirect, Bit-reverse Addressing), Basics of TMS320C55XX DSP Architecture, Memory Map, Interrupt System, Peripheral Devices, Illustrative Examples for assembly coding.	
Module 3 : VLIW Architecture:	**6**
Current DSP Architectures, GPUs as an alternative to DSP Processors, TMS320C6X Family, Addressing Modes, Replacement of MAC unit by ILP, Detailed study of ISA, Assembly Language Programming, Code Composer Studio, Mixed C and Assembly Language programming, On-chip peripherals, Simple applications developments as an embedded environment.	
Module 4: Multi-core DSPs:	**6**
Introduction to Multi-core computing and applicability for DSP hardware, Concept of threads, introduction to P-thread, mutex and similar concepts, heterogeneous and homogenous multi-core systems, Shared Memory parallel programming – OpenMP approach of parallel programming, PRAGMA directives, OpenMP Constructs for work sharing like for loop, Sections, TI TMS320C6678 (Eight Core subsystem).	
Module 5: FPGA based DSP Systems	**8**
Limitations of P-DSPs, Requirements of Signal processing for Cognitive Radio (SDR), FPGA based signal processing design-case study of a complete design of DSP processor.	
Module 6: High Performance Computing using P-DSP:	**4**
Preliminaries of HPC, MPI, OpenMP, multicore DSP as HPC infrastructure.	

Module wise Measurable Students Learning Outcomes : student will

Module 1: Illustrate DSP processor architecture

Module 2: : Develop DSP programming

Module 3: Develop programs using VLIW Architecture CPU

Module 4: Illustrate multicore DSP CPUs

Module 5: Design FPGA based DSP system Module 6: Illustrate High Performance Computing using P-DSP

Semester IV

Sr.No.	Category	Course Code	Course Name
1	PC	3ST693	Dissertation Phase-III
2	PC	3ST694	Dissertation Phase-IV
3	PC	3ST695	Dissertation Phase-IV
5	MC	3IC6**	Mandatory Non Credit Course