HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)

SCHOOL OF ELECTRICAL SCIENCES

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.Tech – ECE
with specialization in
EMBEDDED AND REAL TIME SYSTEMS

CURRICULUM AND SYLLABUS

(Applicable for Students admitted from Academic Year 2020-21)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHOOL OF ELECTRICAL SCIENCES

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE

VISION AND MISSION

MOTTO

To Make Every Man a Success and No Man a Failure.

VISION

To be an International Institute of Excellence, providing a conducive environment for education with a strong emphasis on innovation, quality, research and strategic partnership blended with values and commitment to society.

MISSION

- To create an ecosystem for learning and world class research.
- To nurture a sense of creativity and innovation.
- To instill highest ethical standards and values with a sense of professionalism.
- To take up activities for the development of Society.
- To develop national and international collaboration and strategic partnership with industry and institutes of excellence.
- To enable graduates to become future leaders and innovators.

VALUE STATEMENT

Integrity, Innovation, Internationalization.

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

VISION AND MISSION

VISION

To be a premier academic centre for quality education to meet the industrial standards and research in diverse areas of Electronics and Communication Engineering with social commitment.

MISSION

M1. To impart adequate engineering knowledge to transform students into highly professional engineers as well as good researchers.

M2. To develop their interdisciplinary skills as per the need of the industry and society

M3. To inculcate Entrepreneurship and lifelong learning skills among the students with ethics and social commitment.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 1: Graduates will have strong scientific and Engineering foundation to equip themselves as problem solvers and researchers in real world scenario

PEO 2: Graduates will possess necessary skills on cutting edge technologies to accomplish societal needs by working in multidisciplinary teams.

PEO 3: Graduates will possess attitude for lifelong learning to adapt to technological challenges and emerge as good entrepreneur

PROGRAM OUTCOMES (PO)

PO1:	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2:	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3:	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4:	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5:	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6:	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7:	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8:	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice**.**
PO9:	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10:	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions**.**
PO11:	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12:	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO 1: Able to impart high quality education to the students to face and analyze the challenges in the field of image processing and communication.

PSO 2: Able to analyze, design and validate the systems using hardware and software tools pertaining to Image Processing.

M.TECH- ECE SPECIALIZATION IN EMBEDDED AND REAL TIME SYSTEMS								
SEMESTER - I								
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**TCH**
THEORY COURSES								
1			Advanced Mathematics	2	2	0	3	3
2	PC	ECB4701	Embedded Architecture	3	0	0	3	3
3	PC	ECB4702	Embedded System Networks	3	0	0	3	3
4			Department ELE I	3	0	0	3	3
5			Department ELE II	3	0	0	3	3
6			Research Methodology & IPR	2	0	0	2	2
PRACTICAL COURSES								
7		ECB4791	Embedded Processors Laboratory	0	0	3	2	2
8		ECB4781	Mini project				2	2
Total							**21**	
*Research Methodology & IPR is a compulsory Course.								
SEMESTER - II								
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**TCH**
THEORY COURSES								
1		ECB4703	Real Time Operating System	3	0	0	3	3
2		ECB4704	Fundamentals of Embedded Software	3	0	0	3	3
3		ECB4705	Machine Learning	3	0	0	3	3
4			Department ELE III	3	0	0	3	3
5			Open Elective	3	0	0	3	3
PRACTICAL COURSES								
6		ECB4792	Real Time Operating System Laboratory	0	0	3	2	2
7		ECB4796	Seminar				2	2
Total							**19**	
*One course shall be a MOOC. (same course to all students)								

M.TECH- ECE SPECIALIZATION IN EMBEDDED AND REAL TIME SYSTEMS								
SEMESTER – III								
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**TCH**
THEORY COURSES								
1			Department ELE IV	3	0	0	3	3
PRACTICAL COURSES								
2		ECB4897	Internship *				2	
3		ECB4898	Project Phase –I				8	
Total							**13**	
*Internship to be undergone during vacation between 2nd and 3rd semesters								
SEMESTER – IV								
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**TCH**
PRACTICAL COURSES								
1		ECB4899	Project Phase –II				12	12
Total							**12**	

TOTAL CREDITS: (21+19+13+12) =65

DEPARTMENT ELECTIVE LIST

c	COURSE CODE	COURSE TITLE	L	T	P	C	TCH
DEPARTMENT ELECTIVE I							
1	ECB4721	Graph Theory and Applications	3	0	0	3	
2	ECB4722	Digital System Design and Testing	3	0	0	3	
3	ECB4723	Embedded System Design Using FPGA	3	0	0	3	
DEPARTMENT ELECTIVE II							
1	ECB4724	Deep Learning	3	0	0	3	
2	ECB4725	Advanced Embedded Controllers	3	0	0	3	
3	ECB4726	Sensor-Concepts and Techniques	3	0	0	3	
DEPARTMENT ELECTIVE III							
1	ECB4727	Embedded IoT	3	0	0	3	
2	ECB4728	Automotive Embedded Systems	3	0	0	3	
3	ECB4729	Smart Systems	3	0	0	3	
DEPARTMENT ELECTIVE IV							
1	ECB4730	Robotics Technology and Intelligence	3	0	0	3	
2	ECB4731	Wireless Sensor Networks	3	0	0	3	
3	ECB4732	System on Chip	3	0	0	3	

SEMESTER I

COURSE TITLE	EMBEDDED ARCHITECTURE			CREDITS	3
COURSE CODE	ECB4701	COURSE CATEGORY	PC	L-T-P-S	3-0-0-0
CIA				ESE	
LEARNING LEVEL				ASSESSMENT MODEL	

MODULE 1 – PIC MICROCONTROLLER – ARCHITECTURE (9)
PIC Architecture- RISC Architecture-program memory organization- PIC bank switching, table processing, macros and modules-PIC configuration registers-ROM loaders-timer programming timers 0 and 1-programming timers 2 and 3-serial port programming-interrupt programming.
MODULE 2 – PIC INTERFACING (9)
ADC, DAC and sensor interfacing-erasing and writing to flash-reading and writing to data EEPROM-standard and enhanced CCP modules compare mode programming-capture mode programming-PWM programming- ECCP programming.
MODULE 3 – ARM ARCHITECTURE (9)
ARM7TDMI programmers model-processor modes-program status registers-vector table-assembler rules and directives-predefined register names-macros-assembler operators-literals-loads and store instructions- operand addressing -ARM rotation scheme loading constants and addresses into registers.
MODULE 4 – ARM PROGRAMMING (9)
Data processing operations-loops and branches-LUT-Jump tables binary searches -LDM/STM instruction-full/empty ascending/ descending stacks-subroutines-passing parameters: in registers, by reference, on the stack-ARM APCS-exception handling-memory mapped peripherals-LPC2104-LPC 2132 - Thumb Instruction set- Thumb programmers model-Thumb branch instructions- Thumb Data processing instructions-Thumb single register data transfer- Thumb multiple register data transfer instructions-Thumb implementation.
MODULE 5 – EMBEDDED APPLICATIONS (9)
Two digits multiplexed 7 segment LED-LED Counter with timer Interrupt calculator with keypad -PWM motor control with CCP-read CID register and display on a PC screen-Read write SD cards-USB based pressure display.
TEXT BOOKS

1	Muhammad Ali Mazidi, "PIC Microcontrollers and Embedded Systems Using Assembly and C for PIC18", Pearson Education,2008.
2	John B. Peatman," Design with PIC microcontrollers", Pearson Education, Singapore - 1998.
3	Tim Wilmshurst," Designing Embedded Systems with PICMicrocontrollers: Principles and Applications" Newness Publisher-2007.
4	Andrew Sloss, Dominic Symes, and Chris Wright," ARM System Developer's Guide: Designing and Optimizing System", the Morgan Kaufmann Series, 2004.
5	Steve Furber,"ARM System-on-Chip Architecture", Addison- Wesley Professional; ll edition 2000.
6	ARM Architecture Reference manual, ARM Limited.

7	Ajay V Desmukh, "Microcontrollers: Theory and Applications", Tata McGraw Hill, New Delhi, 2005.

COURSE TITLE	**EMBEDDED SYSTEM NETWORKS**			**CREDITS**	**3**
COURSE CODE	**ECB4702**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-0**
CIA				**ESE**	
LEARNING LEVEL				**ASSESSMENT MODEL**	

MODULE 1 – THE CAN BUS (9)
Introduction – Concepts of Bus Access and Arbitration – Error Processing and Management – Definition of the CAN Protocol ISO 11898-1 – Error Properties, Detection and Processing – Framing.
MODULE 2 – THE CAN PHYSICAL LAYER (9)
Introduction – Signal Propagation – Bit Synchronisation – Network Speed and Range – High Speed CAN – Low Speed CAN – CAN Components – Event-Triggered and Time-Triggered Protocols - CAN Applications**:** Application Layers and Development Tools for CAN - Introduction of Communication Protocols used in Automobiles : LIN, MOST Flexray
MODULE 3 – USB (9)
Introduction **–** Types of USB Transfers: Control Transfer – Bulk Transfer – Interrupt Transfer – Isochronous Transfer – Introduction to the Enumeration Process – Introduction to USB Development Tools.
MODULE 4 – NETWORK SECURITY (9)
Introduction – Confidentiality – Message Integrity - Message Authentication - Digital Signature - Entry Authentication - Key management – Internet Security – Firewalls.
MODULE 5 – TCP/IP FOR EMBEDDED SYSTEMS (9)
Introduction – Embedded SMTP Client – Embedded SMTP Server – Case Studies: IP Security Camera – Vending Machine – Internet Radio – Ethernet Gateway.
TEXT BOOKS

1	Dominique Paret, —Multiplexed Networks for Embedded Systems‖, Wiley, 2007
2	John Hyde, —USB Design by Example‖, Intel University Press, 2001
3	Jan, Axelson, —USB Complete‖, Lake View Research, 2005
4	Behrouz A Forouzan and Firouz Mosharraf, ‖Computer Network – a Top Down Approach‖, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.
5	Edward Insam, —TCP/IP Embedded Internet Applications‖, Elsevier, 2003

	Tim Jones, —TCP/IP Application Layer Protocols for Embedded Systems‖, Charles River Media, 2002

COURSE TITLE	**RESEARCH METHODOLOGY & IPR**			**CREDITS**	**2**
COURSE CODE		**COURSE CATEGORY**	**PC**	**L-T-P-S**	**2-0-0-0**
CIA				**ESE**	
LEARNING LEVEL				**ASSESSMENT MODEL**	

MODULE 1 – RESEARCH PROBLEM FORMULATION (9)

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

MODULE 2 –RESEARCH PROPOSAL AND ETHICS (9)

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

MODULE 3 - DATA ANALYSIS AND INTERPRETATION (9)

Classification of Data, Methods of Data Collection, Sampling, Sampling techniques procedure and methods, Ethical considerations in research Data analysis, Statistical techniques and choosing an appropriate statistical technique, Hypothesis, Hypothesis testing, Data processing software (e.g. SPSS etc.), statistical inference, Interpretation of results.

MODULE 4 - NATURE OF INTELLECTUAL PROPERTY (9)

Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

MODULE 5 – PATENT RIGHTS AND NEW DEVELOPMENTS IN IPR (9)

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TEXT BOOKS

1	Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’,

2	Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3	Ranjit Kumar, 2 nd Edition, “Research Methodology: A Step by Step Guide for beginners”
4	Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
5	Mayall , “Industrial Design”, McGraw Hill, 1992.
6	Niebel , “Product Design”, McGraw Hill, 1974.
7	Asimov, “Introduction to Design”, Prentice Hall, 1962.
8	Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
9	T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008
10	C.R. Kothari, Gaurav Garg, Research Methodology Methods and Techniques , New Age
11	International publishers, Third Edition. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 2nd Edition, SAGE, 2005
12	Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
13	Creswell, John W. Research design: Qualitative, quantitative, and mixed methods, approaches. Sage publications, 2013.
14	Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’,

COURSE TITLE	**EMBEDDED PROCESSORS LABORATORY**			**CREDITS**	**2**
COURSE CODE	**ECB4791**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-3-0**
CIA				**ESE**	
LEARNING LEVEL				**ASSESSMENT MODEL**	

LIST OF EXPERIMENTS

1. Design with ARM and ARM CORTEX Processor
2. I/O Programming, ADC/DAC, Timers and Interrupts.
3. Calculator with keypad and LCD
4. Voltmeter with LCD display
5. Serial communication
6. SPI Interfacing with SD card
7. USB based pressure display
8. CAN based Data acquisition system
9. PWM based motor Control
10. Case Study of internet

COURSE TITLE	MINI PROJECT			CREDITS	2
COURSE CODE	ECB4781	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
CIA				ESE	
LEARNING LEVEL				ASSESSMENT MODEL	

PARTICULARS

EXERCISES:

- To Dismantle and identify the various components, material used, manufacturing process involved and to assemble the following components & Processing Techniques.

SEMESTER II

COURSE TITLE	**REAL TIME OPERATING SYSTEM**			**CREDITS**	**3**
COURSE CODE	**ECB4703**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-0**
CIA				**ESE**	
LEARNING LEVEL				**ASSESSMENT MODEL**	

MODULE 1 – REAL TIME SYSTEMS (9)
Introduction- Issues in real time computing- Structure of a real time system- Task classes- Performance measures for real time systems- Task assignment and scheduling algorithms - Mode changes- Fault tolerant scheduling - Real Time Models.
MODULE 2 – µC/OS- II RTOS CONCEPTS (9)
Foreground/Background process- Resources - Tasks - Multitasking -Priorities - Schedulers -Kernel - Exclusion - Inter task communication-Interrupts - Clock ticks - µC/OS- II Kernel structure - µC/OS- II Initialisation - Starting µC/OS- II.
MODULE 3 – µC/OS- II RTOS FUNCTIONS (9)
Task Management - Time management - Semaphore management - Mutual exclusion semaphore - Event Management –Message management - Memory management - Porting µC/OS- II – Comparison and Study of Various RTOS like QNX- VX Works-PSOS.
MODULE 4 – EMBEDDED LINUX (9)
- Features - Embedded Linux Distributions - Architecture of Embedded Linux - Linux Kernel Architecture – User Space -Root File System - Linux Start-Up Sequence - GNU Cross Platform Tool chain - Porting Traditional RTOS Applications to Linux.
MODULE 5 – REAL-TIME LINUX (9)
Linux and Real-Time - Real-Time Programming in Linux - Hard Real-Time Linux - Building and Debugging - Building the Kernel- Integrated Development Environment - Kernel Debuggers - Embedded Drivers - Board support packages - Introduction to C linux.

TEXT BOOKS

1	Krishna C.M., Kang G. Shin, "Real Time Systems", Tata McGraw-Hill Edition, 2010.
2	Philip A.Laplante, "Real Time Systems Design and Analysis-An Engineers Handbook", II Edition-IEEE Press, IEEE ComputerSociety Press, 2001
3	Jean J Labrosse, "MicroC/OS-II The Real Time Kernel" II Edition,CMP Books, 2002.
4	P. Raghavan,Amol Lad, SriramNeelakandan, "Embedded LinuxSystem Design and Development", Auerbach Publications, Taylor& Francis Group, 2006.

5	Christopher Hallinan, "Embedded Linux Primer, A Practical, Real-World Approach", II Edition Pearson Education, Inc., 2011.

COURSE TITLE	**FUNDAMENTALS OF EMBEDDED SOFTWARE**			**CREDITS**	**3**
COURSE CODE	**ECB4704**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-0**
CIA				**ESE**	
LEARNING LEVEL				**ASSESSMENT MODEL**	

MODULE 1 – EMBEDDED SYSTEMS (9)
Definition and examples of Embedded Systems, Embedded Systems versus General Computing Systems - Characteristics of Embedded Computing Applications, Components of a typical Embedded Systems- Design metrics- Challenges in Embedded Computing Design - Embedded System Design Approach
MODULE 2 – MIXING C AND ASSEMBLY (9)
Programming in Assembly – Register Usage Conventions – Typical Use of Addressing Options – Instruction Sequencing – Procedure Call and Return – Parameter Passing – Retrieving Parameters – pass by-value - Temporary Variables – I/O Programming: Interrupt Driven I/O
MODULE 3 – PROGRAM DESIGN AND ANALYSIS (9)
Models for Programs- State Machines – Data Flow Graphs – Control/Data Flow Graphs – Assembly and Linking Process– Basic Compilation Techniques – Cross Platform Development - Analysis and Optimization of Execution Time, Energy, Power and Program Size – Debugging Techniques
MODULE 4 – OBJECT-ORIENTED ANALYSIS, DESIGN AND MODELLING (9)
OOAD Concepts – Development activities – Managing software development - UML overview – Modeling concepts – Dealing with complexity – Requirement elicitation – Analysis activities – System design activities – overview of Object design.
MODULE 5 – FUNDAMENTALS OF MICROPYTHON PROGRAMMING (9)
Overview of Programming with Python, Native Datatypes and Operators, Python Statements and Conditionals, Functions, Strings, Object oriented programming with Python, Modules and Packages
TEXT BOOKS

1	Wayne Wolf, —Computer as Components – Principles of Embedded Computing System Design‖, Harcourt India Pvt. Ltd., 2001.
2	Daniel Lewis, —Fundamentals of Embedded Software where C and Assembly Meet‖, Prentice Hall Inc, USA, 2002.
3	William von Hagen, —The Definitive Guide to GCC‖, Apress, USA, 2006.
4	Arthur Griffith, — GCC: The Complete Reference‖, McGraw-Hill, USA, 2002.
5	Bernd Bruegge, Allen Dutoit, —Object-oriented Software Engineering – Using UML, Patterns and Java‖, Prentice Hall, USA, 2010.

COURSE TITLE	MACHINE LEARNING			CREDITS	3
COURSE CODE	ECB4705	COURSE CATEGORY		L-T-P-S	3-0-0-0
CIA				ESE	
LEARNING LEVEL				ASSESSMENT MODEL	

	COURSE OUTCOMES	PO
1.	To understand the concepts of Machine Learning	
2	To understand supervised learning and apply neural networks in various applications	
3.	To explain the concepts and algorithms of unsupervised learning	
4	To apply the theoretical and practical aspects of Probabilistic Graphical Models.	
5	To explain the concepts and algorithms of advanced learning	

Prerequisites:

MODULE 1 – INTRODUCTION (9)

Machine Learning–Types of Machine Learning –Machine Learning process-preliminaries, testing Machine Learning algorithms, turning data into Probabilities, and Statistics for Machine Learning-Probability theory –Probability Distributions –Decision Theory.

MODULE 2 – SUPERVISED LEARNING (9)

Linear Models for Regression –Linear Models for Classification-Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models –Decision Tree Learning –Bayesian Learning, Naïve Bayes –Ensemble Methods, Bagging, Boosting, Neural Networks, Multi-layer Perceptron, Feed-forward Network, Error Back propagation -Support Vector Machines.

MODULE 3 – UNSUPERVISED LEARNING (9)

. Clustering-K-means –EM Algorithm-Mixtures of Gaussians –Dimensionality Reduction,Linear Discriminant Analysis, Factor Analysis, Principal Components Analysis, Independent Components Analysis.

MODULE 4 – PROBABILISTIC GRAPHICAL MODELS (9)	
Graphical Models –Undirected Graphical Models –Markov Random Fields –Directed Graphical Models –Bayesian Networks –Conditional Independence properties –MarkovRandom Fields-Hidden Markov Models –Conditional Random Fields(CRFs).	
MODULE 5 – ADVANCED LEARNING (9)	
Sampling-Basic Sampling methods, Monte Carlo, Gibbs Sampling –Computational Learning Theory – Mistake Bound Analysis –Reinforcement learning –Markov Decision processes, Deterministic and Non-deterministic Rewards and Actions, Temporal Difference Learning Exploration.	
TEXT BOOKS	
1.	Christopher Bishop, "Pattern Recognition and Machine Learning" Springer, 2007.
2.	Stephen Marsland, "Machine Learning –An Algorithmic Perspective", Chapman andHall, CRC Press, Second Edition, 2014.
	REFERENCE BOOKS
1	Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
2	EthemAlpaydin, "Introduction to Machine Learning", MIT Press, Third Edition, 2014.
3	Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.
E BOOKS	
1	https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/index.html
2	https://drive.google.com/file/d/1tYo_xIAi8jPqKiaHSPQX9pHaJ8tf8MTd/view
MOOC	
1	https://www.coursera.org/learn/machine-learning
2	http://www.cs.cmu.edu/~tom/10701_sp11/

COURSE TITLE	REAL TIME OPERATING SYSTEM LABORATORY			CREDITS	2
COURSE CODE	ECB4792	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
CIA				ESE	
LEARNING LEVEL				ASSESSMENT MODEL	

LIST OF EXPERIMENTS

1. Programming with RTOS using ARM architecture
2. Task Scheduling Algorithm
3. Multitasking Priorities
4. Inter Task Communication
5. RT Linux based programs.
6. Protocol Development
7. Embedded Programming with Interrupts

DEPARTMENT ELECTIVE – I

COURSE TITLE	**GRAPH THEORY AND APPLICATIONS**			**CREDITS**	**3**
COURSE CODE	**ECB4721**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-0**
CIA				**ESE**	
LEARNING LEVEL				**ASSESSMENT MODEL**	
MODULE 1 – INTRODUCTION (9)					
Simple Graph – Finite and infinite Graphs – Incidence and Degree –Isolated and Pendent Vertices – Sub-Graphs – Isomorphism – Paths and Connections – Connected Graphs, Disconnected Graphs and Components – The Shortest Path Problem – Trees – Spanning Tree Algorithms – Cut Edges and Bonds – Cut Vertices – Cayley's Formula – The Connector Problem.					
MODULE 2 – CUT-SETS, PLANAR AND DUAL GRAPHS AND CONNECTIVITY					

(9)
Cut-sets – Properties – Connectivity – Blocks – Construction of Reliable Communication Networks – Euler Trees and Hamiltonian Cycles – Planar and Dual graphs – Kuratowski's Graphs – Directed Graphs – Euler Digraphs – The Chinese Postman Problem – The Traveling Salesman Problem.
MODULE 3 – MATRIX REPRESENTATION OF GRAPHS AND GRAPH ENUMERATION (9)
Operations on Graphs – Incidence Matrix – Circuit Matrix – Fundamental Circuit Matrix – Cut-set Matrix – Path Matrix – Adjacency Matrix – Types of Enumeration – Counting Labeled and Unlabeled Trees – Polya's Counting Theorem – Graphs Enumeration with Polya's Theorem.
MODULE 4 – MATCHING, COLOURING AND COVERING (9)
Matching – Covering in Bipartite Graphs – Perfect Matching – The Personal Assignment Problem – The Optimal Assignment Problem – Edge Colouring – Edge Chromatic Number – Vizing's Theorem – The Time Tabling Problem – Independent Sets and Cliques – Applications – Vertex Colouring – Chromatic Polynomials – Five Colour Theorem – Applications
MODULE 5 – GRAPH THEORY APPLICATIONS (9)
Network Flows – Transport Networks – Max-Flow Min-Cut Theorem – Activity Networks – Graphs in Game Theory
TEXT BOOKS

1	Narsingh Deo, —Graph Theory with Applications to Engineering and Computer Science‖, Prentice Hall, 2007.
2	Jonathan Gross and Jay Yellen, —Graph Theory and Its Applications‖, Chapman and Hall, 2005.
3	Reinhard Diestel, —Graph Theory‖, Springer Publication, 2006.

COURSE TITLE	**DIGITAL SYSTEM DESIGN AND TESTING**			**CREDITS**	**3**
COURSE CODE	**ECB4722**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-0**
CIA				**ESE**	
LEARNING LEVEL				**ASSESSMENT MODEL**	

MODULE 1 – SYSTEM DESIGN USING PLDS (9)
Basic concepts – Programming technologies - Programmable Logic Element (PLE) - Programmable Array Logic (PLA) - Programmable Array Logic (PAL) – Programmable Logic Architectures – 16L8 – 16R4 – 22V10 –- Design of combinational and sequential circuits using PLDs – Complex PLDs (CPLDs) –Xilinx cool

runner architecture - Design of state machines using Algorithmic State Machines (ASM) chart as a design tool.	
MODULE 2 – FIELD PROGRAMMABLE GATE ARRAYS (9)	
Types of FPGA - Xilinx XC3000 series - Logic Cell Array (LCA) – Configurable Logic Blocks (CLB) – Input /Output Blocks (IOB) - Programmable Interconnection Points (PIP) - Xilinx XC4000 Series – FPGA – Design examples.	
MODULE 3 – INTRODUCTION TO VHDL (9)	
Design process flow - Software tools – Hardware Description Languages – VHDL : Data Objects - Data types - Operators – Entities and Architectures – Components and Configurations – Concurrent signal assignment – Conditional signal assignment - Selected signal assignment – Concurrent statements – Sequential statements – Transport and Inertial delays – Delta delays – Behavioral, Data flow and Structural modeling – Attributes – Generics – Packages and Librar	
MODULE 4 – FAULT MODELING (9)	
Defects, errors, faults, Levels of Fault models, Types, Fault Detection in Combinational Logic circuits: Path sensitization method, Boolean difference method. Fault Detection in sequential logic circuit, Design for Testability: Scan path Testing, Boundary Scan Test, Built in Self Test.	
MODULE 5 – FAULT - TOLERANT SYSTEMS (9)	
Fault avoidance and fault - tolerance - Techniques of fault - tolerance - Hardware fault - tolerance : Static, Dynamic and Hybrid redundancy - Fault - tolerance in memories. Software Fault - tolerance : Design of fault tolerant software - N-version programming - Recovery block - Reliability models for fault tolerant software.	
TEXT BOOKS	
1	Palmer, J.E., Perlman, D.E., "Introduction to Digital Systems",Tata McGraw Hill, New Delhi, Reprint 1996
2	Nelson, V.P., Nagale, H.T., Carroll, B.D., and Irwin, J.D., "Digital Logic Circuit Analysis and Design", PrenticeHall International, Inc., New Jersey, 1995.
3	Bhaskar J., — A VHDL Primer‖, Prentice Hall of India learinng,2012.
4	Charles H Roth and Lizy Kurian John —Digital Systems Design Using VHDL,‖ Cengage Learning,2013
5	Michael L Bushnell, Vishwani D Agrawal, —Essentials of Electronic Testing For digital memory and mixed signal VLSI circuits‖, Springer, 2002.
	Pradhan, D K., "Fault - Tolerant Computing - Theory and Techniques", Vol. I & II, Prentice Hall, 1986.

COURSE TITLE	EMBEDDED SYSTEM DESIGN USING FPGA			CREDITS	3
COURSE CODE	ECB4723	COURSE CATEGORY	PC	L-T-P-S	3-0-0-0
CIA				ESE	
LEARNING LEVEL				ASSESSMENT MODEL	

MODULE 1 – FPGA ARCHITECTURE AND OVERVIEW (9)
Embedded system design flow - Robot Control System - Digital Design Platforms - Microprocessor-based Design - Single-chip Computer/ Microcontroller-based Design -Application Specific Standard Products (ASSPs) - Design Using FPGA - robotic rover application – FPGA Devices - FPGA and CPLD - Architecture of a SPARTAN-3ETM FPGA - Floor Plan and Routing - Timing Model for a FPGA - FPGA Power Usage
MODULE 2 – EMBEDDED SYSTEM DESIGN (9)
FPGA-based Embedded Processor - Design Re-use Using On-chip Bus Interface - Creating a Customized Microcontroller - Robot Axis Position Control - FPGA-based Signal Interfacing and Conditioning - Motor Control Using FPGA- Case Studies for Motor Control –Prototype Using FPGA- FPGA Design Test Methodology.
MODULE 3 – VERILOG CONSTRUCTS (9)
VLSI Design flow- behavioral style, the dataflow style, and structural style - Data types - Constants - Assignment Statement - Operators – Conditional Expressions - Statement types - Vector operations – Bit selects - Functions - Gate level modeling.
MODULE 4 – VERILOG MODELING COMBINATIONAL CIRCUITS (9)
Combinational logic -Adders - Multiplexers - Decoders -Comparator - Parity Generators- ALU - Three state gate - UART model.
MODULE 5 – VERILOG MODELLING SEQUENTIAL CIRCUITS (9)
Modelling Latches and Flip flops-- Sequential logic - Memory - Registers-Counters-Modeling FSM design-Synchronous and Asynchronous - Shift Register- Test bench verification.

TEXT BOOKS

1	Rahul Dubey, "Introduction to Embedded System Design Using Field Programmable Gate Arrays" Springer-Verlag London Limited, 2009
2	John F. Wakerly, Digital Design Principles and Practices", Pearson Education, Asia, III Edition, 2003.
3	Blaine Readler, "Verilog by Example: A Concise Introduction for FPGA Design", Full Arc Press, 2011.
4	J. Bhasker, "A Verilog HDL Primer, Third Edition Hardcover" Star Galaxy Publishing; 3rd edition, 2005.
5	J.Bhasker, "Verilog HDL Synthesis, A Practical Primer", Star Galaxy Publishing; 3rd edition ,1998.

DEPARTMENT ELECTIVE II

COURSE TITLE	DEEP LEARNING	CREDITS	3

Course Code	ECB4724	Course Category		L-T-P-S	3-0-0-0
CIA				ESE	
LEARNING LEVEL				ASSESSMENT MODEL	

	COURSE OUTCOMES	PO
1.	To understand the basic ideas and principles of Neural Networks	
2	To do survey of Deep Learning Development Frameworks	
3.	To solve problems in image classification performances using Tensorflow and Keras	
4.	To understand and implement Deep Learning Architectures	
5.	To apply Deep Learning in various applications	

Prerequisites:

MODULE 1 –BASICS OF NEURAL NETWORKS **9**

Basic concept of Neurons –Perceptron Algorithm –Feed Forward and Back Propagation Networks

MODULE 2 – INTRODUCTION TO DEEP LEARNING **9**

Feed Forward Neural Networks –Gradient Descent –Back Propagation Algorithm –Vanishing Gradient problem –Mitigation –RelU Heuristics for Avoiding Bad Local Minima –Heuristics for Faster Training –Nestors Accelerated Gradient Descent –Regularization –Dropout.

MODULE 3 – CONVOLUTIONAL NEURAL NETWORKS

CNN Architectures –Convolution –Pooling Layers –Transfer Learning –Image Classification using Transfer Learning

MODULE 4 – MORE DEEP LEARNING ARCHITECTURES

STM, GRU, Encoder/Decoder Architectures –Autoencoders –Standard-Sparse –Denoising –Contractive-Variational Autoencoders –Adversarial Generative Networks –Autoencoder and DBM

MODULE 5 – APPLICATIONS OF DEEP LEARNING

Image Segmentation –Object Detection –Automatic Image Captioning –Image generation with Generative Adversarial Networks –Video to Text with LSTM Models –Attention Models for Computer Vision –Case Study: Named Entity Recognition –Opinion Mining using Recurrent Neural Networks –Parsing and Sentiment Analysis using Recursive Neural

Networks –Sentence Classification using Convolutional Neural Networks –Dialogue Generation with LSTMs.	
TEXT BOOKS	
1.	Ian Good Fellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2017
2.	Ragav Venkatesan, Baoxin Li, "Convolutional Neural Networks in Visual Computing", CRC Press, 2018.
3.	Navin Kumar Manaswi, "Deep Learning with Applications Using Python", Apress, 2018.
	REFERENCE BOOKS
1	Francois Chollet, "Deep Learning with Python", Manning Publications, 2018.
2	.Phil Kim, "Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence", Apress , 2017
3	Joshua F. Wiley, "R Deep Learning Essentials", Packt Publications, 2016.
E BOOKS	
1.	http://www.deeplearningbook.org/
2.	http://neuralnetworksanddeeplearning.com/index.html
MOOC	
1	https://www.udacity.com/course/deep-learning-nanodegree--

COURSE TITLE	**ADVANCED EMBEDDED CONTROLLERS**			**CREDITS**	**3**
COURSE CODE	**ECB4725**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-0**
CIA				**ESE**	
LEARNING LEVEL				**ASSESSMENT MODEL**	
MODULE 1 – OVERVIEW OF MIXED SIGNAL PROCESSOR (9)					
Introduction to 16-bit Mixed Signal Controller- Important aspects of Mixed Signal Controller's Hardware – CPU – Functional Block Diagram - Memory Mapping – Clock System - Addressing Modes - Register Mode – Indexed Mode – Introduction to functions – Interrupts - Low Power Modes - Development Environment - Programming and Debugging					
MODULE 2 – PERIPERALS OF MIXED SIGNAL PROCESSOR (9)					
Parallel ports - Digital Inputs/ Outputs – Timers - Watchdog Timer- Capture/Compare module – Generation of Periodic Signal – Generation of PWM Signal - Operation of the ADC Peripheral (ADC10) - Internal Temperature Sensor – Serial Communication Protocols					
MODULE 3 – ARCHITECTURE OF ARM CORTEX – M4 (9)					
ARM Cortex-M4 Processor Core overview - Programmers Model - Memory Model - Exception and Fault Handling - Power Management - Instruction Set Summary - CMSIS Functions - Hardware-Software					

Synchronization - Interrupt Synchronization - Multithreading - Register Map - System Timer - Nested Vectored Interrupt Controller - Floating Point Unit (FPU)-Optional Memory Protection Unit.	
MODULE 4 – PERIPHERALS OF ARM CORTEX – M4 CONTROLLER (9)	
Cortex-M4 Peripherals - Parallel I/O Ports - Timer Interfacing - Pulse Width Modulation - Frequency Measurement - Binary Actuators - Integral Control of a DC Motor – DAC - ADC -Serial Communication Protocols.	
MODULE 5 – PROCESSOR AND CONTROLLER	
Design And Development Of Embedded Systems Using Msp430 Processor And Arm Cortex Controllers**.**	
TEXT BOOKS	
1	Steven F.Barret, Daniel J Pack, —Microcontroller Programming and Interfacing: Texas Instruments MSP430‖ , Morgan & Claypool Publishers, ISBN: 9781608457137
2	John H. Davies, —MSP430 Microcontroller Basics‖, First Edition, Newnes Publication , ISBN: 978-93-80501-85-7, 2010.
3	C.P.Ravikumar. —MSP430 Microcontroller in Embedded System Project‖, First Edition, Elite Publishing House Private Ltd, Dec , ISBN:978-81-88901-46-3, 2011
4	J. W. Valvano, —Embedded Systems: Introduction to ARM Cortex -M Microcontrollers‖, Fourth edition, Volume 1, ISBN: 978-1477508992, 2013
5	J. W. Valvano, —Embedded Systems: Real-Time Interfacing ARM Cortex –Microcontrollers‖, Fourth edition, Volume 2, ISBN: 978-1477508992, 2014
6	Cortex-M4 Devices, Generic User Guide By ARM.

COURSE TITLE	**SENSOR-CONCEPTS AND TECHNIQUES**			**CREDITS**	**3**
COURSE CODE	**ECB4726**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-0**
CIA				**ESE**	
LEARNING LEVEL				**ASSESSMENT MODEL**	
MODULE 1 – SENSORS / TRANSDUCERS (9)					
Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization. -Inductive Sensors: Sensitivity and Linearity of the Sensor –Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors.					
MODULE 2 – THERMAL AND MAGNETIC SENSORS (9)					
Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors – Acoustic Temperature Sensor – Dielectric Constant and Refractive Index thermosensors – Helium Low Temperature Thermometer – Nuclear Thermometer – Magnetic Thermometer – Resistance Change Sensors and the Principles Behind – Magneto-resistive Sensors – Anisotropic Magneto resistive Sensing – Semiconductor Magnetoresistors– Hall Effect and Sensors – Inductance and Eddy Current Sensors– Angular/Rotary Movement Transducers – Synchros – Synchroresolvers - Eddy Current Sensors – Electromagnetic Flowmeter – Switching Magnetic Sensors SQUID Sensors					

MODULE 3 – RADIATION AND ELECTRO ANALYTICAL SENSORS (9)	
Introduction – Basic Characteristics – Types of Photosensistors/Photo detectors– Xray and Nuclear Radiation Sensors– Fiber Optic Sensors, the Electrochemical Cell – The Cell Potential – Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Polarization – Concentration Polarization– Reference Electrodes - Sensor Electrodes – Electro ceramics in Gas Media.	
MODULE 4 – SMART SENSORS (9)	
Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation– Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface– The Automation.	
MODULE 5 – ACTUATORS (9)	
Pneumatic and Hydraulic Actuation Systems- Actuation systems – Pneumatic and hydraulic systems - Directional Control valves – Presure control valves – Cylinders - Servo and proportional control valves – Process control valves – Rotary actuators.	
TEXT BOOKS	
1	D. Patranabis – “Sensors and Transducers” –PHI Learning Private Limited.
2	W. Bolton – “Mechatronics” –Pearson Education Limited.
3	Sensors and Actuators – D. Patranabis – 2nd Ed., PHI, 2013.

DEPARTMENT ELECTIVE III

COURSE TITLE	EMBEDDED IOT			CREDITS	3
COURSE CODE	ECB4727	COURSE CATEGORY	PC	L-T-P-S	3-0-0-0
CIA				ESE	
LEARNING LEVEL				ASSESSMENT MODEL	
MODULE 1 – FUNDAMENTALS AND APPLICATIONS OF IoT (9)					
Introduction to Internet of Things (IoT)– Functional Characteristics – Recent Trends in the Adoption of IoT – Societal Benefits of IoT, Health Care –– Machine to Machine (M2M) - Smart Transportation – Smart Living – Smart Cities- Smart Grid					

MODULE 2 – IoT ARCHITECTURE (9)	
Functional Requirements - Components of IoT: Sensors – Actuators – Embedded Computation Units – Communication Interfaces – Software Development	
MODULE 3 – COMMUNICATION PRINCIPLES (9)	
RFID – ZigBEE – Bluetooth – Internet Communication- IP Addresses - MAC Addresses - TCP and UDP – IEEE 802 Family of Protocols – Cellular-Introduction to EtherCAT.	
MODULE 4 – COMMUNICATION INTERFACE IN IoT (9)	
IEEE 802.11 Wireless Networks Attacks: Basic Types, WEP Key Recovery Attacks, Keystream Recovery Attacks against WEP – RFID Security – Security Issues in ZigBEE: Eavesdropping Attacks, Encryption Attacks – Bluetooth Security: Threats to Bluetooth Devices and Networks.	
MODULE 5 – CLOUD SECURITY CONCEPTS (9)	
Confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, defence in depth, least privilege, how these concepts apply in the cloud, what these concepts mean and their importance in PAAS, IAAS and SAAS. e.g. User authentication in the cloud; Cryptographic Systems- Symmetric cryptography, stream ciphers, block ciphers, modes of operation, public-key cryptography, hashing, digital signatures, public-key infrastructures, key management, X.509 certificates, OpenSSL.	
TEXT BOOKS	
1	Adrian McEwen and Hakim Cassimally, —Designing the Internet of Things‖, John Wiley and Sons Ltd, UK, 2014.
2	Olivier Hersent, David Boswarthick and Omar Elloumi, —The Internet of Things: Key Applications and Protocols‖, John Wiley and Sons Ltd., UK 2012.
3	Dieter Uckelmann, Mark Harrison, Florian Michahelles, —Architecting the Internet of Things‖, Springer, New York, 2011.
4	Johnny Cache, Joshua Wright and Vincent Liu, —Hacking Exposed Wireless: Wireless Security Secrets and Solutions‖, Tata McGraw Hill, New Delhi, 2010
5	Himanshu Dwivedi, Chris Clark and David Thiel, —Mobile Application Security‖, Tata McGraw Hill, Nw Delhi, 2010.
6	Vijay Madisetti, Arshdeep Bahga, —Internet of Things (A Hands-on Approach), Universities Press, 2015.
7	Tim Mather, Subra Kumaraswamy, ShahedLatif, “Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance” O'Reilly Media; 1 edition [ISBN: 0596802765], 2009

COURSE TITLE	**AUTOMOTIVE EMBEDDED SYSTEMS**			**CREDITS**	**3**
COURSE CODE	**ECB4728**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-0**
CIA				**ESE**	
LEARNING LEVEL				**ASSESSMENT MODEL**	

MODULE 1 – INTRODUCTION (9)	
Current trends in modern automobiles – – Drive by wire Systems -Vehicle functional domains and their *requirements - Components of an Automobile Electronic system and their functions: Sensors, Actuators, Control Units and Software* structure of Control units	
MODULE 2 – POWER TRAIN, BODY AND CHASSIS DOMAIN (9)	
Power Train Domain: Gasoline engine management -Body Electronics: Vehicle power supply controllers – Lighting technology– Adaptive lighting system – Automatic wiper system – Door control modules - Vehicle to vehicle communication - Chassis Domain: Antilock Braking System (ABS) – Electronic Stability Program (ESP)	
MODULE 3 – AUTOMOTIVE INFOTRONICS (9)	
Automotive Vision System - Advanced Driver Assistant Systems (ADAS) – Multimedia systems- Intelligent Automotive Systems: Navigation Systems – Adaptive Cruise Control (ACC)	
MODULE 4 – SAFETY AND SECURITY SYSTEMS (9)	
Active and Passive safety- Airbag System – Seat belt tightening system - Electronic Brake Force Distribution (EBD) - Lane Departure Warning System - Anti-theft technologies – Electronic Immobilizers – Remote Keyless entry.	
MODULE 5 – AUTOMOTIVE NETWORKING (9)	
Cross-system functions - Bus systems: Requirements, classification and applications – coupling of networks- CAN – LIN – MOST –Diagnostic Interfaces – examples of networked vehicles.	
TEXT BOOKS	
1	Nicolas Navet and Francoise Simonot-Lion, —Automotive Embedded Systems Handbook‖, CRC Press, USA, 2008.
2	Robert Bosch, Automotive Electrics Automotive Electronics‖, Wiley (5TH Edition),2010.
3	LjuboVlacic, Michel Parent &Furnio Harshima, —Intelligent Vehicle Technologies: Theory and Applications, Butterworth-Heinemann publications, 2001.
4	Robert Bosch, —Automotive Hand Book‖, SAE (5TH Edition),2000.
5	Bechhold, —Understanding Automotive Electronics‖, SAE 1998.

COURSE TITLE	SMART SYSTEMS			CREDITS	3
COURSE CODE	ECB4729	COURSE CATEGORY	PC	L-T-P-S	3-0-0-0
CIA				ESE	
LEARNING LEVEL				ASSESSMENT MODEL	

MODULE 1 – INTRODUCTION TO SENSOR DEVICES (9)
Piezoresistive pressure sensor- Piezoresistive Accelerometer - Capacitive Sensing- Accelerometer and Microphone - Resonant Sensor and Vibratory Gyroscope - Low-Power, Low Voltage Sensors- Micro Electro Mechanical Systems Analysis and Design of MEMS Devices- Nano Sensors.
MODULE 2 – INTERFACING SENSOR INFORMATION AND MCU (9)
Amplification and Signal Conditioning- Integrated Signal Conditioning- Digital conversion- MCU Control- MCUs for Sensor Interface- Techniques and System Considerations- Sensor Integration.
MODULE 3 – CONTROL TECHNIQUES AND STANDARDS (9)
Control of Sensors using - State Machines, Fuzzy Logic, Neural Networks, Adaptive Control. Control Application using - CISC, RISC, DSP Control and IEEE 1451 Standards.
MODULE 4 – COMMUNICATION FOR SMART SENSORS (9)
Wireless Data Communications- RF Sensing- Telemetry- Automotive Protocols- Industrial Networks- Home Automation- MCU Protocols.
MODULE 5 – PACKAGING, TESTING AND RELIABILITY IMPLICATIONS OF SMART SENSORS (9)
Semiconductor Packaging- Hybrid Packaging- Packaging for Monolithic Sensors- Reliability Implications- Testing Smart Sensors- HVAC Sensor Chip.

TEXT BOOKS

1	Randy Frank, "Understanding Smart Sensors", Artech House, Second Edition, 2011Boston,
2	Minhang Bao, "Analysis and design principles of MEMS devices", Elsevier Publications, 2005,USA.
3	Nadim Maluf and Kirt Williams, "An Introduction to Micro Electro Mechanical Systems Engineering", Second Edition, Artech House Publishers, June 2004, USA.
4	Gabriel M. Rebeiz, "RF MEMS: Theory, Design, and Technology", Wiley-Interscience; 1st edition, 2002,UK
5	John A. Pelesko and David H. Bernstein, " Modeling MEMS and NEMS", CRC Press, 2002,UK
6	Rai-choudhury, "MEMS and MOEMS Technology and Applications",PHI, 2010.
7	Ananthasuresh, "Micro and Smart Systems" Wiley Publishers,2013.

DEPARTMENT ELECTIVE - IV

COURSE TITLE	ROBOTICS TECHNOLOGY AND INTELLIGENCE			CREDITS	3
COURSE CODE	ECB4730	COURSE CATEGORY	PC	L-T-P-S	3-0-0-0
CIA				ESE	
LEARNING LEVEL				ASSESSMENT MODEL	

MODULE 1 – INTRODUCTION TO ROBOTICS (9)
Robotics - basic components - classification - specifications, Robotic sensors- proximity and range sensors, ultrasonic sensor, touch and slip sensor. Vision system - image processing and analysis – data reduction, segmentation, feature extraction and object recognition. Robotic drives and actuators - electric, hydraulic, pneumatic - selection.
MODULE 2 – ROBOT CONTROL (9)
Control of robot manipulator - state equations - constant solutions - linear feedback systems, single-axis PID control - PD gravity control - computed torque control, variable structure control and impedance control.
MODULE 3 – ROBOT END EFFECTORS AND TRAJECTORY PLANNING (9)
End effectors - classification - mechanical, magnetic, vacuum and adhesive grippers. Gripper force analysis and gripper design. Work space analysis and motion analysis - pick and place operation, continuous path motion, interpolated motion, and straight line motion manipulator kinematics - kinematic equation using homogeneous transformation and robot dynamics.
MODULE 4 – ROBOT INTELLIGENCE AND TASK PLANNING (9)
Artificial Intelligence - techniques - state space - search problem reduction - predicate logic means and end analysis -problem solving - robot learning - task planning - basic problems in task planning - AI in robotics and Knowledge Based Expert System in robotics
MODULE 5 – INDUSTRIAL ROBOTICS (9)
Robot cell design and control - cell layouts - multiple robots and machine interference - work cell design - work cell control - interlocks – error deduction and recovery - work cell controller - robot cycle time analysis. Safety in robotics, Applications of robot and future scope.

TEXT BOOKS

1	Robert J Schilling, "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India, New Delhi, 2013.
2	Deb. S. R, "Robotics Technology and Flexible Machine Design", Tata McGraw Hill, 2010.
3	Mikell. P. Groover, Michell Weis, Roger. N. Nagel, Nicolous G. Odrey, "Industrial Robotics Technology, Programming and Applications ", McGraw Hill, Int 2012.
4	Richard D Klafter Thomas A.Chmielewski and Michael Negin, "Robotic Engineering: An Integrated approach", Prentice Hall of India, New Delhi, 2010.
5	Nagrath I.J., Mittal R.K., "Robotics and Control", Tata McGraw Hill, Sixth reprint, 2007.

COURSE TITLE	WIRELESS SENSOR NETWORKS			CREDITS	3
COURSE CODE	ECB4731	COURSE CATEGORY	PC	L-T-P-S	3-0-0-0
CIA				ESE	
LEARNING LEVEL				ASSESSMENT MODEL	

MODULE 1 – BASIC CONCEPTS of WSN (9)
Introduction to Wireless Sensor Networks (WSNs) and Their Applications – Constraints and Challenges – Single-node Architecture – Hardware components- Energy consumption of sensor nodes- Operating systems and execution environments- Network architecture.
MODULE 2 – WIRELESS TRANSMISSION TECHNOLOGY BROADBAND NETWORKS (9)
Wireless Channels and Communication Fundamentals – Physical layer and transceiver design considerations in WSNs - Energy usage profile- Choice of modulation scheme - Dynamic modulation scaling - Antenna considerations - Fundamentals of Medium Access Control (MAC) Protocols – Low duty cycle protocols and wake-up concepts—Contention-based protocols - Scheduled- based protocols – IEEE 802.15.4 MAC protocol.
MODULE 3 – ROUTING AND DATA GATHERING PROTOCOLS (9)
Challenges and design Issues in Wireless Sensor Networks –Routing strategies - Flooding and gossiping – Hierarchical Routing: Low energy Adaptive Clustering Hierarchy (LEACH) – Power efficient Gathering in Sensor Information Systems (PEGASIS)– Data centric Routing: Sensor Protocols for Information Via Negotiation (SPIN) - Directed Diffusion – Energy aware routing – Geographical routing.
MODULE 4 – NETWORK MANAGEMENT FOR WSNS (9)
Network Management Requirements – Network Management Design Issues – Issues Related to Network Management: Naming and addressing: Fundamentals-Address and Name Management in WSN-Assignment of MAC addresses- Localization and positioning: Properties - Possible approaches- Proximity-Trilateration and Triangulation
MODULE 5 – EMBEDDED OPERATING SYSTEMS (9)
Operating Systems for Wireless Sensor Networks – Introduction - Operating System Design Issues - Examples of Operating Systems – TinyOS – Mate – MagnetOS –MANTIS.

TEXT BOOKS

1	Kazem Sohraby, Daniel Minoli and Taieb Znati, —Wireless Sensor Networks – Technology, Protocols and Applications‖, Wiley, 2007..
2	Edgar Callaway, —Wireless Sensor Networks: Architectures and Protocols‖, CRC Press, 2004.
3	Holger Karl and Anderson Willis, —Protocols and Architectures for Wireless Sensor Networks‖, Wiley, 2005.

COURSE TITLE	SYSTEM ON CHIP			CREDITS	3
COURSE CODE	ECB4732	COURSE CATEGORY	PC	L-T-P-S	3-0-0-0
CIA				ESE	
LEARNING LEVEL				ASSESSMENT MODEL	

MODULE 1 – INTRODUCTION (9)
System trade offs and evolution of ASIC Technology – System on chip concepts and methodology – SoC design issues – SoC challenges and components.
MODULE 2 – DESIGN METHODOLOGIC FOR LOGIC CORES (9)
SoC Design Flow – On-chip buses – Design process for hard cores – Soft and firm cores – Designing with hard cores, soft cores – Core and SoC design examples
MODULE 3 – DESIGN METHODOLOGY FOR MEMORY AND ANALOG CORES (9)
Embedded memories – Simulation modes – Specification of analog circuits – A to D converter – D to A converter – Phase-located loops – High speed I/O
MODULE 4 – DESIGN VALIDATION (9)
Core level validation – Test benches- SoC design validation – Cosimulation – Hardware/software coverification.
MODULE 5 – SOC TESTING (9)
SoC Test issues – Testing of digital logic cores – Cores with boundary scan – Test methodology for design re-use – Testing of microprocessor cores – Built in self-test method – Testing of embedded memories- Verification methodologies - Introduction to system Verilog.

TEXT BOOKS

1	Rochit Rajsuman, —System-on-a-chip: Design and Test‖, Artech House, London, 2000.
2	Laung-Terng Wang, Charles E Stroud and Nur A Toubq, —System on Chip Test Architectures: Nanometer Design for Testability‖, Morgan Kaufmann, 2008.
3	Wgel Badawy, Graham A Jullien, —System-on-Chip for Real-Time Applications‖, Kluwer Academic Press, 2003.
4	Rajanish K Kamat, Santosh A Shinde, Vinod G Shelake, —Unleesh the System-on-Chip using FPGAs and Handle C, Spinger 2009.