ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾ ವಿದ್ಯಾಲಯ

(ಸ್ವಾಯತ್ತ ವಿದ್ಯಾಸಂಸ್ಥೆ)

ಬೆಂಗಳೂರು ೫೬೦ ೦೧೯

BMS COLLEGE OF ENGINEERING

(Autonomous College under VTU)

BANGALORE - 560019

ELECTRONICS & COMMUNICATION ENGINEERING

SCHEME & SYLLABUS

M. TECH.

(ELECTRONICS)

I to IV SEMESTER

2018-19 Batch Onwards

ECE

B M S C E

ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು

(ಸ್ವಾಯತ್ತ ವಿದ್ಯಾ ಸಂಸ್ಥೆ)

ಬುಲ್ ಟೆಂಪಲ್ ರಸ್ತೆ, ಬೆಂಗಳೂರು – ೫೬೦ ೦೧೯

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VTU

Department of Electronics and Communication Engineering

Scheme and Syllabus: M.Tech (Electronics)
Batch 2018 onwards

INSTITUTE VISION

Promoting Prosperity of mankind by augmenting Human Resource Capital through Quality Technical Education & Training.

INSTITUTE MISSION

Accomplish excellence in the field of Technical Education through Education, Research and Service needs of society.

DEPARTMENT VISION

To emerge as a Centre of Academic Excellence in Electronics, Communication and related domains through Knowledge acquisition, Knowledge dissemination and Knowledge generation meeting global needs and standards.

DEPARTMENT MISSION

Imparting quality education through state of the art curriculum, conducive learning environment and Research with scope for continuous improvement leading to overall Professional Success.

PROGRAM EDUCATIONAL OBJECTIVES

The department has defined the following PEOs for the PG program in Electronics

PEO1: Graduates shall be capable of building their career in related industries, R&D establishments as well as in teaching with their scholarly knowledge with respect to advanced topics in Applied Electronics and VLSI Engineering.

PEO2: Graduates shall be capable of Conceptualizing and Analyzing Engineering problems of societal importance related to Embedded Systems, VLSI and Signal Processing, conduct independent Research leading to technology solutions and communicate the outcomes through verbal and written mechanisms.

PEO3: Graduates shall be able to Collaborate, Manage and Execute projects in teams using appropriate tools/technologies with utmost Professionalism and acceptable good practices**.**

PROGRAM OUTCOMES

Program Outcomes (POs) are attributes acquired by the student at the time of graduation. These attributes are measured at the time of graduation and hence computed every year for the outgoing batch. The POs are addressed and attained through the Course Outcomes (COs) of various courses of the curriculum.

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

Distribution of Credits

Category	No of Credits
Program Core Courses (PC)	**26**
Program Elective Courses (PE)	**15**
Institution Core Courses (IC)	**2**
Open Elective Courses (OE)	**4**
Internship	**9**
Project Work	**28**
Seminar	**4**
Non-credit Mandatory Course	**4 Units**

Total Number of Credits (1st Sem. ~ 4th Sem.) = 88Credit

I Semester

Subject Code	Course Title	Credits			CREDITS
		L	T	P	
18ECELBSAM	Applied Mathematics	3	0	0	3
18ECELGCES	Advanced Embedded Systems	3	0	1	4
18ECELPCSD	Digital System Design	3	0	1	4
18ECELPCCN	Advanced Computer Networks	3	0	0	3
18ECELPEZZ	Elective -1	3	0	0	3
18ECELPEZZ	Elective -2	3	0	0	3
18ALLPICRM	Research Methodology	2	0	0	2
Total					22

Choices for Elective -1 and Elective -2			
18ECELPEVD	CMOS VLSI Design	18ECELPESN	Wireless Sensor Network
18ECELPEAE	Automotive Electronics	18ECELPEOT	Optimization Technique
18ECELPECT	Advanced Control Theory	18ECELPEME	MEMS

Note: Two electives to be chosen from the table above. Elective shall be offered for a minimum strength of six candidates (out of 18) / eight candidates (out of 24)

II Semester

Subject Code	Course Title	Credits			CREDITS
		L	T	P	
18ECELPCVV	VLSI Verification & Testing	3	1	0	4
18ECELPCSO	Synthesis & Optimization of Digital Circuits	3	1	0	4
18ECELGCRT	Real Time Operating Systems	3	0	1	4
18ECELPEZZ	Elective -3	3	0	0	3
18ECELPEZZ	Elective -4	3	0	0	3
18ECELOEZZ	Open Elective	4	0	0	4
Total					22

Choices for Elective -3 and Elective -4			
18ECELPESP	Advanced DSP	18ECELPESL	Scripting Language
18ECELPELP	Low Power VLSI	18ECELPENE	Nano Electronics
18ECELPENN	Artificial Neural Networks		

Note: Two electives to be chosen from the table above. Elective shall be offered for a minimum strength of six candidates (out of 18) / eight candidates (out of 24)

Open Elective offered by the program	
18ECELOEIT	Internet of Things

Note: Students are also allowed to opt for open elective from other PG programs from other departments throughout the institute

III Semester

Subject Code	Course Title	Credits			CREDITS
		L	T	P	
18ECELGEZZ	Elective 5	2	1	0	3
18ECELPWP1	Project work Phase 1	0	0	8	8
18ECELPCIN	Internship	0	0	9	9
18ECELSR01	Technical Seminar-1	0	0	2	2
Total					22

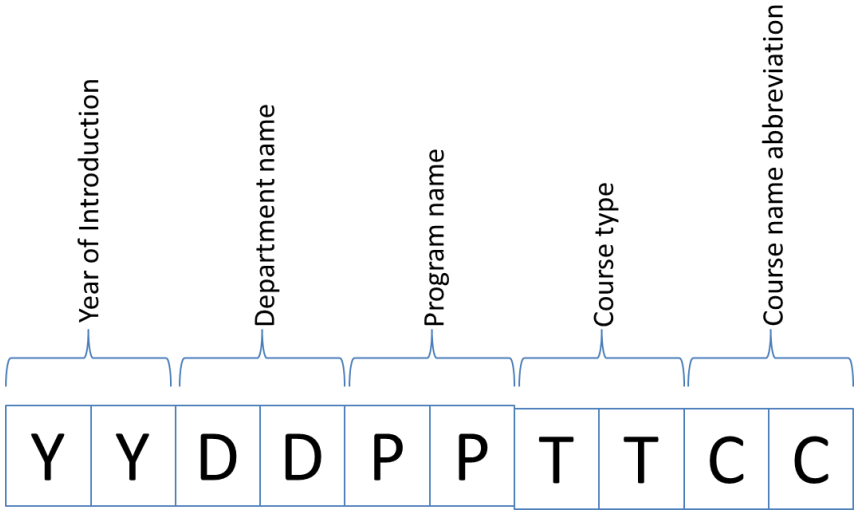
Choices for Elective -5			
18ECELPEML	Machine Learning & AI	18ECELGEDE/ 18ECDCGEDE	Detection & Estimation Techniques
18ECELPENS	Network Security& Cryptography	18ECELPESC	System on Chip

Note: One elective to be chosen from the table above. Elective shall be offered for a minimum strength of six candidates (out of 18) / eight candidates (out of 24)

IV Semester

Subject Code	Course Title	Credits			CREDITS
		L	**T**	**P**	
18ECELSR02	Technical Seminar-2	0	0	2	2
18ECELPWP2	Project Work-Phase 2	0	0	20	20
18ECELNCAC	Audit Course	0	0	0	2Units*
Total					22

Course Code Interpretation



YY: All courses introduced during the A.Y 2018 will have this part of the code as “18”

DD: All courses offered in department of electronics would have this part of the code as “EC”

PP: This part of the code would indicate the PG program. For MTech.(Electronics), this part of the code would be “EL”

TT: This part of the code would indicate the type of the course. Following are the course types:

Course type	Code
Program Core	PC
Program Elective	PE
Group Core	GC
Group Elective	GE
Institutional Core	IC
Open Elective	OE

CC: This part of the code would be a two letter abbreviation for the course title. For example, course titled “Advanced Embedded Systems” gets abbreviated as “ES”

Note: For the course on institutional core, the part of the code “DD” and “PP” would, together get replaced as “ALLP” (ALL Programs)

I Sem Syllabus

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COURSE CODE	18ECELBSAM	COURSE TITLE	APPLIED MATHEMATICS
CREDITS	3	L-T-P	3-0-0

COURSE OUTCOME

CO1	Demonstrate knowledge and understanding of the underlying concepts of random variables and stochastic processes	**PO3**
CO2	Demonstrate knowledge of the mathematical concepts and computational aspects of linear algebra and graph theory	**PO3**
CO3	Analyze domain related engineering problems and develop analytical problem solving approach making use of the theoretical concepts.	**PO1**

Unit 1

Review of basic probability theory. Definition of random variables and probability distributions, probability mass and density functions, expectation operator, illustrative examples

Unit 2

Moments, central moments, characteristic functions, probability generating functions – illustrations, Poisson, Gaussian and Erlang distribution examples. Pair of random variables – Joint PMF, PDF, CDF.

Unit 3

Random Processes – Classification, Stationary, WSS and ergodic random process. Auto-correlation function-properties, Gaussian random process, Engineering Applications of Random processes.

Unit 4

Linear Algebra: Introduction to vector spaces and sub-spaces, definitions, illustrative example. Linearly independent and dependent vectors- Basis-definition and problems. Linear transformations-definitions, Matrix form of linear transformations - Illustrative examples, Computation of eigen values and eigen vectors of real symmetric matrices- Given's method.

Unit 5

Computational Graph Theory: Graph enumerations and optimization: DFS-BFS algorithm, shortest path algorithm, min-spanning tree and max-spanning tree algorithm, basics of minimum cost spanning trees, optimal routing trees, optimal communication trees

Text Books:

1. S L Miller and D C Childers**, "Probability and random processes: application to signal processing and communication**", Academic Press / Elsevier 2004.
2. David C. Lay, "**Linear Algebra and its Applications**", 3rd Edition, Pearson Education, 2003.
3. GeirAgnarsson and Raymond Greenlaw "**Graph Theory- Modeling, Applications and Algortihms",**Pearson Education, 2007.

Reference books:

1. A.Papoulis and SU Pillai, **"Probability, Random variables and stochastic processes",** McGraw Hill 2002
2. Roy D. Yates and David J. Goodman, **Probability and Stochastic Processes: A friendly introduction for Electrical & Computer Engineers**
3. MIT Open courseware**, Introduction to Linear Algebra, Course 18.06**
4. 4 Nausing Deo, "**Graph Theory with applications to Engineering and Computer Science**", Prentice Hall of India, 1999.

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COURSE CODE	18ECVEGCES / 18ECELGCES	COURSE TITLE	ADVANCED EMBEDDED SYSTEMS
CREIDTS	4	L-T-P	3-0-1

CO1	Comprehend concepts in the field of Embedded Systems	**PO3**
CO2	Apply concepts to build and program Embedded Systems	**PO3**
CO3	Develop C programs for execution on microcontroller/SOC development board based on ARM architecture. Develop Python programs to interface with Embedded Systems.	**PO3**
CO4	Engage on market survey of various available Computer/Embedded architecture based on performance, power consumption and prizing criteria.	**PO2**

Students Prerequisite:

Introduction course on Embedded Systems, Microcontrollers (any) Basic C Programming Skills

Unit 1

Introduction to ARM architecture and Real Time Embedded Systems:

Introduction to ARM Architecture, Difference between Microcontroller, Application Processor and Realtime Processor architectures. Detail study of ARM Cortex-M processor, Introduction to peripheral interface scheme in ARM processors. Operating Modes and Exceptions, Time Management in Embedded Systems, ARM Instruction Set and its features.

Unit 2

Embedded C Programming: Detail study of bitwise operators in C. Arrays, Structures and Unions. Pointers and Dynamic Memory allocation. Pre-processor Directives in C. Modular C programming approach. Relook into data types of C. Memory Map and Storage Classes of C. Storage Type Qualifiers.

Unit 3

Python Programming: Introduction Python Programming, data types, lists, tuples, dictionaries, conditional statements, iterative statements, functions. File and I/O handling, serial device interfaced to external devices. Strings and data formatting, integer, bytes, hexadecimal representation.

Unit 4

Firmware Architecture for Embedded Systems: Super Loop, Interrupt driven, RTOS, CMSIS RTOS, Low Power Operations. Speed Power Product, Optimization for time and space.

Unit 5

Debugging Techniques for Embedded Systems: Introduction to GNU Debugger gdb µVision IDE based debugging techniques. Single Stepping, Break Points, Watch Points, and Memory Probing. Simulation using µVision.

Lab Prerequisite:

Any ARM Cortex M0-4 microcontroller development board on Windows-7 or above platform, Kiel µVision MDK IDE.C compiler on Windows, preferably Cygwin. USB to Serial devices. Lab and Theory sessions are integrated.

Lab Work: 2 hrs/week Course Outcomes:

At the end of the laboratory work, students will be able to:

- Use Embedded programming language like Embedded C and Scripting Language like Python
- Design and Use Cortex-Mx Microcontroller based embedded Systems

List of Experiments:

Many more lab experiments based on each topic and peripheral. Study datasheet and technical reference manual of case-study Cortex-Mx microcontroller.

1. Install Keil MDK for ARM along with development board drivers. Interface development board to development PC. Download and test blinky code example.
2. Develop a super loop to transmit ADC data on UART to PC every one second.
3. Develop a interrupt routine to accept 100 bytes of data from PC over UART and send out on SPI or I2C bus. Consider buffering and non-buffering approaches.
4. Utilize CMSIS RTOS and develop a user interface console with keyboard, display and any serial interface protocol.
5. Transfer periodically sampled data from any analog peripheral to either PC or another analog peripheral using DMA process. Code could be standalone or CMSIS based.
6. Develop Python code to interface external peripherals connected to PC.
7. Send emails using Python program.
8. Post data on to any webpage using Python.

9. Read data from webpage Python program and transfer the same to microcontroller over UART.
10. Receive data from microcontroller on to PC using Python and either email that data or post it on to any webpage.

Reference Books:

1. Joseph Yiu, “Definitive guide to the ARM Cortex-M3”, Latest available edition

2. Hennessy and Patterson, “Computer Architecture: A Quantitative Approach”, Latest available edition

3. Shibu K V, “Introduction to Embedded Systems”, Latest available edition

4. Michael J Pont, “Embedded C”, Latest available edition

5. Leonard Eddison, “Python Programming”, Latest available edition

6. Technical reference manual and datasheets of Cortex-M3 microcontroller and other components.

7. Relevant online tutorials and references.

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COURSE CODE	18ECELPCSD	COURSE TITLE	DIGITAL SYSTEM DESIGN
CREDITS	4	L-T-P	3-0-1

COURSE OUTCOMES

CO1	Ability to demonstrate In-depth knowledge of Verilog / System Verilog for digital system design.	**PO3**
CO2	Analyze and design different combinational and sequential digital circuits using Verilog / System Verilog	**PO3**
CO3	Engage in independent study to prepare a technical document and oral presentation for a design of digital system using Verilog.	**PO2**
CO4	Engage in critical analysis to arrive at a valid conclusion through research to provide an optimal solution for a design and validation of digital system.	**PO1**

Unit-1

Introduction and Methodology: Digital system design options and trade-offs, Design methodology and technology overview, Digital Systems and Embedded Systems, Real-World Circuits & Models**.**

Unit-2

Combinational & sequential Design: Combinational Components and Circuits, Verification of Combinational Circuits**,** Storage elements, Counters, Sequential Data paths and Control, Clocked Synchronous Timing Methodology, State machine design, synthesis issues, test benches.

Unit-3

Memories: Concepts, Memory Types, Error Detection and Correction**,** Verilog modelling

Unit-4

System Verilog Data Types: Overview of System Verilog, Built in Data types, fixed and dynamic arrays, Queues, associative arrays, linked lists, array methods, choosing a storage type, creating new types with type def, creating user defined structures, type conversion, Enumerated types, constants and strings, Expression width.

Unit-5

System Verilog Building blocks - Modules, programs, subroutines, package, interface with example code, Procedural statements, Tasks, Functions and void functions, Task and function overview.

REFERENCES:

1. Peter J. Ashenden, **"Digital Design: An Embedded Systems Approach Using VERILOG"**, Elesvier, 2010.

2. Digital Design using Verilog, Elsevier, 2007 W.Wolf

3. Stuart S, Simon David & Peter Flake "**System Verilog for Design"**A guide to using system verilog for Hardware design and modelingSpringer publication2nd Edition, 2006.

4. Chris Spear, "**SystemVerilog for Verification"**A guide to learning the Test bench language features', Springer Publications, 2nd Edition, 2010

5. http://www.testbench.in

Lab Experiments: Using Verilog/ System Verilog

1. Write Verilog code for the design of 8-bit
2. Carry Look Ahead adder
3. Ripple Carry Adder
4. BCD Adder &Subtractor
5. Write a Verilog code for the design of 8-bit Booth's multiplier
6. Write a Verilog code to design a 8-bit Magnitude comparator
7. Write a Verilog code to design a 4-bit universal shift register
8. Write a Verilog code to design 8-bit parity generator
9. Write Verilog Code for 3-bit Arbitrary Counter to generate 0,1,2,3,6,5,7 and repeats.
10. Design a Mealy and Moore Sequence Detector using Verilog to detect Sequence. Eg 11101 (with and without overlap) etc.,

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COURSE CODE	18ECELPCCN	COURSE TITLE	ADVANCED COMPUTER NETWORKS
CREDITS	3	L-T-P	3-0-0

COURSE OUTCOMES

CO1	To analyze Network architectures and fundamental protocols.	**PO3**
CO2	To apply the knowledge of internetworking concepts in various applications	**PO3**
CO3	To Analyze and design using various network parameters	**PO3**

Unit 1

Foundation: Building a Network, Requirements, Perspectives, Scalable Connectivity, Cost-Effective Resource sharing, Support for Common Services, Manageability, Protocol layering, Performance, Bandwidth and Latency, Delay X Bandwidth Product, Perspectives on Connecting, Efficient transport of packet voice calls, Achievable throughput in an input queuing packet switch; the importance of quantitative modelling in the Engineering of Telecommunication Networks.

Unit 2

Internetworking- I : Switching and Bridging, Datagrams, Virtual Circuit Switching, Source Routing, Bridges and LAN Switches, Basic Internetworking (IP), What is an Internetwork ?, Service Model, Global Addresses, Datagram Forwarding in IP, subnetting and classless addressing, Address Translation(ARP), Host Configuration(DHCP), Error Reporting(ICMP), Virtual Networks and Tunnels.

Unit 3

Internetworking- II: Network as a Graph, Distance Vector (RIP), Link State (OSPF), Metrics, The Global Internet, Routing Areas, Routing among Autonomous systems (BGP), IP Version 6(IPv6), Mobility and Mobile IP.

Unit 4

End-to-End Protocols: Simple Demultiplexer (UDP), Reliable Byte Stream (TCP), End-to-End Issues, Segment Format, Connecting Establishment and Termination, Sliding Window Revisited, Triggering Transmission, Adaptive Retransmission, Record Boundaries, TCP Extensions, Queuing Disciplines, FIFO, Fair Queuing.

Unit 5

Application: The Domain Name System (DNS), Electronic Mail (SMTP, POP, IMAP, MIME), World Wide Web (HTTP), Network Management (SNMP).

Text books:

1: Larry Peterson and Bruce S Davis "Computer Networks: A System Approach" 5th Edition, Elsevier -2014.

2: Douglas E Comer, "Internetworking with TCP/IP, Principles, Protocols and Architecture" 6th Edition, PHI – 2014.

Reference Books:

1. Anurag Kumar, D. Manjunath, Joy Kuri, "**Communication Networking – An Analytical Approach**", 1St Edition, Published by Elseveir,2004
2. Nader F. Mir, "**Computer Communication Networks**",3rd Edition, Pearson Education

II Sem Syllabus

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COURSE CODE	18ECELPCVV	COURSE TITLE	VLSI VERIFICATION & TESTING
CREDITS	4	L-T-P	3-1-0

COURSE OUTCOMES

CO1	Ability to acquire knowledge on verification and testing to apply and analyze for VLSI designs	**PO3**
CO2	Design and Simulate the test bench architecture using system Verilog and analyze coverage reports	**PO3**
CO3	Engage in independent study of different digital system using EDA tool and make an effective oral presentation	**PO2**
CO4	Apply modern tools to obtain 100% code coverage & functional coverage by analysing the set of input constraints and assertions in test benches	**PO1**

Unit 1

Importance of Verification: Concepts of verification, importance of verification, Reconvergence model, Formal verification, Equivalence checking, Model checking, Functional verification.

Functional verification approaches: Black box verification, white box verification, grey box verification. Testing versus verification, Verification reuse, The cost of verification.

Unit 2

Simulators: Stimulus and response, Event based simulation, cycle based simulation, Co-simulators, verification intellectual property: hardware modellers, waveform viewers.

Code & Functional Coverage: statement coverage, path coverage, expression coverage, FSM coverage, what does 100%coverage mean? Item Coverage, cross coverage, Transition coverage, what does 100% functional mean? Assertions, Issue tracking & Metrics.

Unit 3

The verification plan: The role of verification plan: specifying the verification plan, defining the first success. Levels of verification: unit level verification, reusable components verification, ASIC and FPGA verification, system level verification, board level verification, verifying strategies. Directed and random based approach, Directed test cases.

Unit 4

Verification Methodology: Introduction to Universal Verification Methodology, Overview of UVM Base Classes and simulation phases in UVM and UVM macros.

Unit 5

Built-In Self-Test: Test pattern generation for BIST, Output response analysis, Circular BIST, BIST Architectures.

Text Books:

1. Janick Bergeron, **"Writing test benches: functional verification of HDL models"**, 2nd edition, Kluwer Academic Publishers

2. Lala Parag K., **Digital Circuit Testing and Testability**, New York, Academic Press, 1997.

References:

1. https://en.wikipedia.org/wiki/**Universal_Verification_Methodology.**

2.The **Verification Methodology Cookbook** - online textbook

3. For Formal Verification - "**Formal Verification** - An Essential Toolkit for Modern VLSI Design"

4. Vishwani D Agarwal, ―Essential of Electronic Testing for Digital, Memory and Mixed Signal Circuits‖, Springer, 2002.

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COURSE CODE	18ECELPCSO	COURSE TITLE	SYNTHESIS & OPTIMIZATION OF DIGITAL CIRCUITS
CREDITS	4	L-T-P	3-1-0

CO1	Understand the process of synthesis and optimization in a top down approach for digital circuits models using HDLs.	**PO3**
CO2	Apply different scheduling algorithms with resource binding and without resource binding for pipelined sequential circuits and extended sequencing models	**PO3**
CO3	Apply different two level optimization algorithms for combinational circuits	**PO3**
CO4	Ability to execute projects after getting familiar with VHDL and Cadence	**PO2**

Unit 1

Circuits And Models: Design of Microelectronic Circuits - Computer Aided Synthesis and optimization, Boolean Algebra and Application,

Unit 2

Hardware Modelling Hardware Modelling Languages, abstract models, compilation and behavioural optimization.

Unit 3

Architectural Level Synthesis And Optimization: The Fundamental Architectural synthesis Problems-Area and performance Estimation- Critical path, Control unit synthesis-synthesis of pipelined circuits.

Unit 4

Scheduling Algorithms and Resource Sharing: model for the scheduling problems, Unconstrained Scheduling-ASAP Algorithm-ALAP Scheduling Algorithm- Scheduling with Resource Constraints.

Unit 5

Logic-Level Synthesis and Optimization: Logic optimization Principles, operations on two level logic covers, Algorithms and logic Minimization and Encoding problems-

Text Books:

1. Giovanni De Micheli, "**Synthesis and optimization of Digital Circuits**", Tata McGraw-Hill, 2003.
2. John Paul Shen, Mikko H. Lipasti, "**Modern processor Design**", Tata McGraw Hill, 2003

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COURSE CODE	18ECVEGCRT/ 18ECELGCRT	COURSE TITLE	REAL TIME OPERATING SYSTEMS
CREIDTS	4	L-T-P	3-0-1

CO1	Design high performance software applications with real time deterministic response.	**PO3**
CO2	Configure and Optimize Embedded RTOS to achieve desired High Performance Computing response.	**PO3**
CO3	Make an effective oral presentation pertaining to RTOS and related high performance computing concepts.	**PO2**
CO4	Engage on Literature survey about High Performance & Deterministic systems, both from hardware and software perspective and submit a report	**PO1**

Prerequisite:
Introduction course on Embedded Systems and Embedded Systems Programming, I Semester.

Unit 1

Introduction to ARM SoC architecture: ARM Application Processor features, Virtualization extension of ARM. Memory Management Unit, Virtual Addressing, Cache controller, Advanced Microprocessor Bus Architecture (AMBA). Usability of FPGA modules interfaced to ARM-AP.

Unit 2

RTOS: Introduction to OS, Defining RTOS, Services, Characteristics of RTOS, Tasks, tasks its States and Scheduling, Synchronization, Communication and Concurrency. Semaphores. File Management (open, read, write, close) and IO services, IOCTL. Case Study RTOS**:** RT- Linux. Process management and IPC: Parent-Child Process, Process Priority, Various types of Process. Exceptions, Interrupts, and Timers. Signals, Pipes, Message Ques, and FIFO. Memory management.

Unit 3

Network Programming: Machine to Machine Interface. Sockets, ports, UDP, TCP/IP, client server model, socket programming, 802.11 and Bluetooth.
(Modules 4 and 5 are complete lab sessions)

Unit 4

Developing a Hardware Module in FPGA part of SoC: VHDL/Verilog code development for case study peripheral module.

Unit 5

Device Drivers, Developing Interface Code for module developed in M4: C program-based application layer code and kernel level code to configure and access data in/out of hardware module developed in M4.

Text books:

1. Steve Furber, "ARM System-on-Chip Architecture", The Zynq Book, by Crockett, Elliot, Enderwitz & Stewart, University of Strathclyde Glasgow, 2014
2. Advanced UNIX Programming, Richard Stevens
3. Embedded Linux: Hardware, Software and Interfacing – Dr. Craig Hollabaugh

Lab Prerequisite:

Xilinx, ZyncSoC development board along with Raspberry-Pi-3B, Windows-7 or above OS platform, Optional GNU/Linux OS platform. All module will have integrated lab sessions.

List of Lab Experiments:

1. Raspberry Pi 3: Booting the Board with multiple OS,
2. Programming of GPIO, Programming of Serial Peripherals, Control of ADC.
3. Zynq Board: Implement Timers and GPIO modules in FPGA and control it with ARM SOC.
4. Implement a USB generic serial emulator device on FPGA, interface it with Raspberry Pi 3.
5. Develop a sample GNU/Linux Device Driver for modules developed in lab experiment 3.

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COURSE CODE	18ECELPEVD	COURSE TITLE	CMOS VLSI DESIGN
CREDITS	3	L-T-P	3-0-0

COURSE OUTCOMES

CO1	Apply the concepts of MOS system in digital VLSI design	**PO3**
CO2	Analyze the electrical and physical properties, Switching characteristics and interconnect effect of a MOS system in digital VLSI design	**PO3**
CO3	Design dynamic logic circuits, Semiconductors Memory circuits, and different CMOS logic circuits.	**PO3**
CO4	Use modern tools to simulate Schematic and Layout of Digital circuits individually/ in groups and make an effective oral presentation and documentation on advanced topics related to the course by referring IEEE	**PO2, PO1**

Unit 1

MOS Transistor: The Metal Oxide Semiconductor (MOS) Structure, MOS System under External Bias, Structure and Operation of MOS Transistor, MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects.

Unit 2

MOS Inverters: Static Characteristics of CMOS Inverter. MOS Inverters, Layout and stick diagrams

Unit 3

Switching Characteristics and Interconnect Effects: Delay-Time Definition, Calculation, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitic, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters.

Unit 4

Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High Performance Dynamic CMOS Circuits.

Unit 5

Semiconductor Memories: Introduction, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM).

References:

1. Sung Mo Kang &Yosuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design", Tata McGraw-Hill, Third Edition.
2. Neil Weste and K. Eshragian, "Principles of CMOS VLSI Design: A System Perspective", Second Edition, Pearson Education (Asia) Pvt. Ltd. 2000.

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COURSE CODE	18ECELPEAE	COURSE TITLE	AUTOMOTIVE ELECTRONICS
CREDITS	3	L-T-P	3-0-0

COURSE OUTCOMES

CO1	Ability to carry out quantitative and qualitative assessment of performance of automotives in terms of the underlying system dynamics with emphasis on emission and fuel consumption	**PO3**
CO2	Ability to design and implement in-vehicle communication systems of varied capabilities and capacities as electronic embedded systems	**PO3**
CO3	Ability to architect (for new development) or migrate (in case of existing design) automotive ECUs and infrastructure requirements in compliance to state-of-the-art standards	**PO3**

Unit-1

Automotive Fundamentals Overview – Four Stroke Cycle, Engine Control, Ignition System, Spark plug, Spark pulse generation, Ignition Timing, Drive Train, Transmission, Brakes, Steering System, Battery, Starting System

Electronic Engine Control – Engine parameters, variables, Engine Performance terms, Electronic Fuel Control System, Electronic Ignition Control, Idle sped control, EGR Control

Air/Fuel Systems – Fuel Handling, Air Intake System, Air/ Fuel Management

Exhaust After-Treatment Systems – AIR, Catalytic Converter, Exhaust Gas Recirculation (EGR), Evaporative Emission Systems

Vehicle Motion Control – Cruise Control, Chassis, Power Brakes, Antilock Brake System (ABS), Electronic Steering Control, Power Steering, Traction Control, Electronically controlled suspension

Integrated Body – Climate Control Systems, Electronic HVAC Systems, Safety Systems – SIR, Interior Safety, Lighting, Entertainment Systems

Automotive Diagnostics – Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics

Unit 2

Sensors and actuators – Oxygen (O2/EGO) Sensors, Throttle Position Sensor (TPS), Engine Crankshaft Angular Position (CKP) Sensor, Magnetic Reluctance Position Sensor, Engine Speed Sensor, Ignition Timing Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Manifold Absolute Pressure (MAP) Sensor - Strain gauge and Capacitor capsule, Engine Coolant Temperature (ECT) Sensor, Intake Air Temperature (IAT) Sensor, Knock Sensor, Airflow rate sensor, Throttle angle sensor – Fuel Metering Actuator, Fuel Injector, Ignition Actuator

Unit 3

Automotive in-Vehicle communication systems: Characteristics and constraints, In-car embedded networks: CAN, FlexCAN, TTCAN, Flexray, LIN, MOST and IDB1394 protocols, Car-to-Car (C2C) and Car-to-infrastructure (C2I) communications **–**Programmers model of communication controllers – communication hardware and bus – case studies

Unit 4

Standardization in Automotive ECU Development: Traditional approach and its shortcomings, Worldwide standards, AUTOSAR based automotive ECU development, AUTOSAR architecture, AUTOSAR methodology, AUTOSAR in practice, Conformance testing, Migration to AUTOSAR, AUTOSAR in OEM-supplier collaboration

Unit 5

Working definition of ITS - Broad scope - Current status of ITS and State-of-the-Art - Fundamental issues in ITS - Principal characteristics of ITS - Scientific validation of ITS designs through modeling and simulation

Modeling and simulation techniques for ITS design - Introduction - Virtual and physical process migration strategies for ITS designs - Software techniques underlying the process migration strategies - Implementation issues - Simulation results and performance analysis Future issues in ITS - New Meta-level Principles for an untapped ITS technological mine - Examples of formidable challenges and opportunities

Text Books:

1. William B. Ribbens, “Understanding Automotive Electronics”, 6th Edition, SAMS/Elsevier Publishing
2. Nicolas Navet, “Automotive Embedded Systems Handbook”, Industrial Information Technology Series, CRC press.
3. Robert Bosch GmbH, “Automotive Electrics Automotive Electronics”, 5th edition, Wiley publications.
4. Ronald K Jurgen, “Automotive Electronics Handbook”, McGraw-Hill, Inc, 2nd edition. 5.SumitGhosh, Tony S Lee, “Intelligent Transportation System” – Smart and Green Infrastructure, 2nd Edition CRC Press

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COURSE CODE	18ECELPECT	COURSE TITLE	ADVANCED CONTROL THEORY
CREDITS	3	L-T-P	3-0-0

COURSE OUTCOMES

CO1	Ability to conceptualize physical systems dynamics using relevant mathematical formulations	**PO3**
CO2	Ability to analyze physical systems mathematically alongside their physical interpretation.	**PO3**
CO3	Ability to design physical systems from a control theoretic perspective	**PO3, PO2**

Unit 1

Mathematical models of Physical systems, Performance specification, Root locus analysis and design, frequency domain analysis and design.

Unit 2

Sampled data control systems – Introduction to control systems, Sampling process; Sample and Hold circuit; Types of signals; Mathematical operation on discrete time signals; Z- transform; Properties of Z-transforms; Inverse Z-transform; Solving the differential equations using Z transform; and its applications.

Unit 3

State space analysis- concepts of states; State space formulation; State model of linear system; State diagram and signal flow graph; State-space representation using physical variables- Electrical systems and mechanical translational system; State-space model of Mechanical translational systems and Rotational systems.

Unit 4

Stability, Controllability and Observability- Linear discrete-time systems(LDS); Transfer function of LDS systems; Stability analysis of sampled data control systems using Jury's stability test, Bilinear transformation and Root locus technique; Similarity transformation; Eigen values and Eigen vectors; Canonical form of state model; Controllability test and Observability test.

Unit 5

Nonlinear systems- Introduction to Nonlinear systems; common physical nonlinearities; Describing function; Derivation of describing function of dead-zone and saturation nonlinearity; Derivation of describing function of saturation nonlinearity; Derivation of describing function of dead-zone nonlinearity and Backlash nonlinearity; Derivation of describing function of relay with dead-zone and hysteresis; Phase plane and phase trajectories; Singular points; Stability analysis of nonlinear systems using phase trajectories; Lyapunov's stability criterion; Popov's stability criterion.

Text Books:

1. Tai-Ran Hsu, MEMS and Microsystems, 2nd Edition, Wiley, 2008
2. Mohamad Gad El Hak, MEMS Design and Fabrication, 2nd Edition, CRC Press, 2006.

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COURSE CODE	18ECELPESN	COURSE TITLE	WIRELESS SENSOR NETWORKS
CREDITS	3	L-T-P	3-0-0

COURSE OUTCOMES

CO1	Demonstrate understanding of the fundamental problems, trade-offs and design issues that arise in sensor network, as well as identify and critically evaluate sensor network technologies and solution approaches.	**PO3**
CO2	Understand the details of several particular protocols as example implementations of fundamental principles, and analyze specific protocols extracting the salient concepts	**PO3**
CO3	Engage in research and presentation in the area of sensor networks	**PO2**

Unit 1

Introduction and Overview of Wireless Sensor Networks: Introduction, Background of Sensor Network Technology, Applications of Sensor Networks, Basic Overview of the Technology, Basic Sensor Network Architectural Elements, Brief Historical Survey of Sensor Networks, Challenges and Hurdles, Applications of Wireless Sensor Networks, Basic Wireless Sensor Technology- Introduction, Sensor Node Technology-Overview, Hardware and Software, Sensor Taxonomy, WN Operating Environment, WN Trends.

Unit 2

Wireless Transmission Technology and Systems : Introduction, Radio Technology Primer, Propagation and Propagation Impairments, Modulation, Available Wireless Technologies, Campus Applications, MAN/WAN Applications, Medium Access Control Protocols for Wireless Sensor Networks – Introduction, Background, Fundamentals of MAC Protocols, Performance Requirements, Common Protocols, MAC Protocols for WSNs, Schedule-Based Protocols, Random Access-Based Protocols, Sensor-MAC Case Study, IEEE 802.1, LR-WPANs Standard Case Study.

Unit 3

Network Management for Wireless Sensor Networks: Introduction, Network Management Requirements, Traditional Network Management Models, Simple Network Management Protocol, Telecom Operation Map, Network Management Design Issues, Example of Management Architecture: MANNA, Other Issues Related to Network Management.

Unit 4

Operating Systems for Wireless Sensor Networks: Operating System Design issues, examples of Operating Systems, Performance and Traffic Management – Introduction, Background, Design Issues.

Unit 5

Protocols: Routing Protocols, Transport Protocols, Performance Modelling of WSNs, Performance Metrics, Basic Models, Network Models, Case Study: Simple Computation of the System Life Span analysis.

TEXT BOOKS

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

2. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.

REFERENCE BOOKS

1. K. Akkaya and M. Younis, "A survey of routing protocols in wireless sensor networks", Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325--349
2. Anna Hac, "Wireless Sensor Network Designs", John Wiley & Sons Ltd

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COURSE CODE	18ECELPEOT	COURSE TITLE	OPTIMIZATION TECHNIQUE
CREDITS	3	L-T-P	3-0-0

COURSE OUTCOMES

CO1	To appreciate the motivational factors for system optimization with case studies of linear and non-linear system	**PO3**
CO2	To understand the mathematical concepts to implement system optimization	**PO3**
CO3	To gather skill and be able to practice linear programming technique for system optimization	**PO2**

Unit-1

Single Variable Non-Linear Unconstrained Optimization: One dimensional Optimization methods:-Uni-modal function, elimination methods, ,, Fibonacci method, golden section method, interpolation methods – quadratic & cubic interpolation methods.

Unit-2

Multi variable non-linear unconstrained optimization: Direct search method – Univariant method – pattern search methods – Powell's- Hook -Jeeves, Rosenbrock search methods-gradient methods, gradient of function, steepest decent method, Fletcher Reeves method, variable metric method.

Unit-3

Linear Programming: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints. Simulation – Introduction – Types- steps – application – inventory – queuing – thermal system

Unit–4

Integer Programming: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method Stochastic programming: Basic concepts of probability theory, random variables- distributions-mean, variance, correlation, co variance, joint probability distribution- stochastic linear, dynamic programming.

Unit-5

Geometric Programming: Polynomials – arithmetic – geometric inequality – unconstrained G.P , constrained G.P (<= TYPE ONLY) Non-traditional optimization Techniques: Genetic Algorithms-Steps-Solving simple problems, Comparisons of similarities and dissimilarities between traditional and non-traditional techniques-Particle Swarm Optimization (PSO)-Steps(Just understanding)-Simulated Annealing-Steps-Simple problems.

Text Books:

1. Optimization theory & Applications / S.S. Rao / New Age International.
2. Engineering Optimization-Kalyan Deb/ PHI
3. Introductory to operation Research / Kasan & Kumar / Springer
4. Optimization Techniques theory and practice / M. C. Joshi, K. M. Moudgalya / Narosa Publications
5. Operation Research / H. A. Taha /TMH
6. Optimization in operations research / R. L Rardin
7. Optimization Techniques /Benugundu & Chandraputla / Pearson Asia

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COURSE CODE	18ECELPEME	COURSE TITLE	MEMS
CREDITS	3	L-T-P	3-0-0

COURSE OUTCOMES

CO1	Gain a fundamental understanding of standard microfabrication techniques and the issues surrounding them	**PO3**
CO2	Critically analyze microsystems technology for technical feasibility as well as practicality.	**PO3**
CO3	Apply knowledge of microfabrication techniques and applications to the design and manufacturing of an MEMS device or a microsystem	**PO3**
CO4	Understand the unique requirements, environments, and applications of MEMS	**PO3**

Unit 1

Overview of MEMS and Microsystems: MEMs and Microsystems, Evolution of micro fabrication, Microsystems and miniaturization, Application of Microsystems, Markets for Microsystems

Working Principles of Microsystems: Introduction, MEMS and Micro actuators, Microfluidics, Micro actuators with Mechanical inertia.

Unit 2

Engineering Science for Microsystems Design: Introduction, Molecular theory of matter and intermolecular forces, Doping of semiconductor, Plasma physics, Electrochemistry

Unit 3

Thermo fluid Engineering and Microsystems Design: Introduction, Clock Skew and Sequential Circuit Performance, Clock Generation and Synchronization

Unit 4

Designing Arithmetic Building Blocks: Introduction, Basic equation in continuum fluid dynamics, laminar fluid flow in circular conduits, Computational fluid dynamics and incompressible fluid flow in micro-conduits

Unit 5

Microsystems Fabrication Processes: Introduction, Photolithography, Diffusion, Oxidation, Chemical vapour deposition.

REFERENCES:

1. Tai-Ran Hsu, MEMS and Microsystems, 2nd Edition, Wiley, 2008
2. Mohamad Gad El Hak, MEMS Design and Fabrication, 2nd Edition, CRC Press, 2006

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COURSE CODE	18ECELPESP	COURSE TITLE	ADVANCED DSP
CREDITS	3	L-T-P	3-0-0

COURSE OUTCOMES

CO1	Understand the theoretical concepts of advanced DSP, including FIR/IIR filter design, multirate DSP and adaptive filters	**PO3**
CO2	Visualize and apply the concepts of DSP to real life problems of practical and numerical nature.	**PO3**
CO3	Work in teams to progress towards group assignments and to choose, read and assimilate one IEEE journal paper covering an application of DSP	**PO2**
CO4	Create a standard documentation and presentation of the work performed by their team	**PO2**

Unit 1

Introduction: Overview of signals and systems, The concept of frequency in continuous time and discrete time signals, sampling in T/F domain, Analog to digital and digital to analog conversion. Discrete Fourier transform: The DFT / IDFT pair, Properties of DFT, Linear filtering methods based on the DFT.

Unit 2

Design of digital filters: General considerations, design of FIR filters, Design of IIR filters from analog filters.

Unit 3

Multirate digital signal processing: decimation by a factor 'D', Interpolation by a factor 'I', sampling rate conversion by a factor 'I/D', Polyphase implementations, Multistage implementation of sampling rate conversion, Engineering applications of multirate signal processing

Unit 4

Adaptive filter: Adaptive direct form FIR filters, The LMS algorithm (without proof), applications of adaptive filters

Text Book:

1. Robert. O. Cristi, "**Modern Digital signal processing**", Cengage Publishers, India, 2003.
2. S. K. Mitra, "**Digital signal processing: A computer based approach**", 3rd edition, TMH, India, 2007.
3. E.C. Ifeachor, and B. W. Jarvis,"**Digital signal processing: A Practitioner's approach**", Second Edition, Pearson Education, India, 2002,
4. Proakis, and Manolakis, "**Digital signal processing**", 3rd edition, Prentice Hall, 1996

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COURSE CODE	18ECELPELP	COURSE TITLE	LOW POWER VLSI
CREDITS	3	L-T-P	3-0-0

COURSE OUTCOMES

CO1	Extend the knowledge on basics of MOSFETs and Power Dissipation in MOS circuits to obtain the concepts of different techniques for power optimization.	**PO3**
CO2	Ability to apply the low power concepts to find the static and dynamic power consumption in a design	**PO3**
CO3	Ability to design the power optimized circuit for the given specification.	**PO3**
CO4	Usage of EDA tool to implement the designed circuit with techniques of power optimization in the design and justify obtained report by classroom presentation.	**PO2**
CO5	Understand the journal research papers related to low power and update the knowledge for new techniques to incorporate in projects of the specified stream.	**PO1, PO2**

Unit 1

Basics of MOS circuits, Sources of Power dissipation: Dynamic Power Dissipation -Short Circuit Power, Switching Power, Glitching Power, Static Power Dissipation, Degrees of Freedom.

Unit 2

Supply Voltage Scaling Approaches: Device feature size scaling Multi-Vdd Circuits Architectural level approaches: Parallelism, Pipelining Voltage scaling using high-level transformations Dynamic voltage scaling Power Management

Unit 3

Switched Capacitance Minimization Approaches: Hardware Software Tradeoff Bus

Encoding Two's complements Vs Sign Magnitude Architectural optimization, Clock Gating Logic styles

Unit 4

Leakage Power minimization Approaches: Variable-threshold-voltage CMOS (VTCMOS) approach, Multi-threshold-voltage CMOS (MTCMOS) approach, Power gating Transistor stacking Dual-V_t assignment approach (DTCMOS)

Unit 5

Special Topics: Adiabatic Switching Circuits, Battery-aware Synthesis, Variation tolerant design, CAD tools for low power synthesis

Text Books:

1. Sung Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata Mcgrag Hill.
2. Bellamour, and M. I. Elmasri, Low Power VLSI CMOS Circuit Design, Kluwer Academic Press, 1995.
3. Anantha P. Chandrakasan and Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers, 1995.

References:

1. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Design, Wiley-Inter science, 2000.
2. NPTEL http://nptel.iitm.ac.in Computer Science and Engineering, Department of Computer Science and Engineering ,IIT Kharagpur

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COURSE CODE	**18ECELPENN**	**COURSE TITLE**	**ARTIFICIAL NEURAL NETWORKS**
CREDITS	**3**	**L-T-P**	**3-0-0**

COURSE OUTCOMES

CO1	Ability to distinguish different types of ANNs from the point of view of their working and performance	**PO3**
CO2	Ability to analyze the working of ANNs using their underlying mathematical paradigms	**PO3**
CO3	Ability to design and develop algorithms for feature selection and training for ANNs	**PO3**

Unit 1

Statistical pattern recognition: Classification and regression, Pre-processing and feature extraction, The curse of dimensionality, Polynomial curve fitting, Model complexity, Multivariate non-linear functions, Bayes' theorem, Decision boundaries, Minimizing risk.
Probability Density Estimation: Parametric methods, Maximum likelihood, Bayesian inference, Sequential parameter estimation, Non-parametric methods, Mixture models

Unit 2

Single-Layer Networks: Linear discriminant functions, Linear separability, Generalized linear discriminants, Least-squares techniques, The perceptron, Fisher's linear discriminant
The Multi-layer Perceptron: Feed-forward network mappings, Threshold units, Sigmoidal units, Weight-space symmetries, Higher-order networks, Projection pursuit regression, Kolmogorov's theorem, Error back-propagation, The Jacobian matrix, The Hessian matrix

Unit 3

Radial Basis Functions: Exact interpolation, Radial basis function networks, Network training, Regularization theory, Noisy interpolation theory, Relation to kernel regression, Radial basis function networks for classification, Comparison with the multi-layer perceptron, Basis function optimization, Supervised training

Unit 4

Error Functions: Sum-of-squares error, Minkowski error, Input-dependent variance, Modelling conditional distributions, Estimating posterior probabilities, Sum-of-squares for classification, Cross-entropy for two classes, Multiple independent attributes, Cross-eutropy for multiple classes, Entropy, General conditions for outputs to be probabilities

Parameter Optimization Algorithms: Error surfaces, Local quadratic approximation, Linear output units, Optimization in practice, Gradient descent, Line search, Conjugate gradients, Scaled conjugate gradients, Newton's method, Quasi-Newton methods, The Levenberg-Marquardt; algorithm

Unit 5

Pre-processing and Feature Extraction: Pre-processing and post-processing, Input normalization and encoding, Missing data, Time series prediction, Feature selection, Principal component analysis, Invariances and prior knowledge

Learning and Generalization: Bias and variance, Regularization, Training with noise, Soft weight sharing, Growing and pruning algorithms, Committees of networks, Mixtures of experts, Model order selection, Vapnik-Chervonenkis dimension.

Bayesian Techniques, Bayesian learning of network weights, Distribution of network outputs, Application to classification problems, The evidence framework for αand β, Integration over hyperparameters, Bayesian model comparison, Committees of networks, Practical implementation of Bayesian techniques, Monte Carlo methods, Minimum description length

Text Book:

Christopher M Bishop, "Neural Networks for Pattern Recognition", Clarendon Press, Oxford, 1995

Suggested Reading:

1. B. Yegnanarayana, Artificial Neural Networks, Prentice-Hall of India, New Delhi, 1999
2. Simon Haykin, Neural networks and learning machines, Pearson Education, 2011
3. Jacek M Zurada, Introduction to artificial neural systems, PWS publishing Company, 1992
4. David E Rumelhart, James McClelland, and the PDP research group, Eds, Parallel and Distributed Processing: Explorations in Microstructure of Cognition, Vol 1, Cambridge MA: MIT Press, 1986a
5. James McClelland, David E Rumelhart, and the PDP research group, Eds, Parallel and Distributed Processing: Explorations in Microstructure of Cognition, Vol 2, Cambridge MA: MIT Press, 1986b
6. David Rumelhart, James McClelland, and the PDP research group, Eds, Parallel and Distributed Processing: A handbook of models, Cambridge MA: MIT Press, 1989

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COURSE CODE	18ECELPESL	COURSE TITLE	SCRIPTING LANGUAGE
CREDITS	3	L-T-P	3-0-0

COURSE OUTCOMES

CO1	Demonstrate proficiency in handling Python syntax and semantics and be fluent in the use of Python flow control and functions	**PO3**
CO2	Create, run and manipulate Python Programs using core data structures like Lists, Dictionaries and use Regular Expressions	**PO1**
CO3	Implement exemplary applications related to Network Programming, Web Services and Databases in Python and prepare a technical document	**PO2, PO1**

Unit-1

Introduction: Introduction to python, History, Features of Python, Coding guidelines in python, Variables, Types of Variables – strings, Boolean, Numeric types, Logical and Arithmetic Operators, Operations on Strings, Variable Comparison, Lists, Tuples, Regular Expressions and Dictionary

Unit-2

Control statements and Loops: Conditional Statements, If else statements, Nested if else, Pass statements, Loops in pythons, For loop, While loop, Nested looping, Range functions

Unit-3

Functions: Creating functions, calling functions, Argument passing and return statements, Recursion, Variable –length Argument

Unit-4

Modules and imports: Built in Modules, Usage of modules, Installing the modules, Making own modules.

Unit-5

Classes and objects: OOPS terminologies, Creating Class, Creating instance object Accessing Attributes, Creating instance objects, Built in class attributes, Inheritance, Overriding Methods, Overloading Operators, Data Hiding, Implementation: Stack, Queue and asynchronous and synchronous threads and also priority based threading.

Text Books:

1. Charles R. Severance, "Python for Everybody: Exploring Data Using Python 3", 1st Edition, CreateSpace
2. Independent Publishing Platform, 2016. (http://do1.drchuck.com/pythonlearn/EN_us/pythonlearn.pdf))

3. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2ndEdition, Green Tea Press, 2015. http://greenteapress.com/thinkpython2/thinkpython2.pdf)

Reference Books:

1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt.ltd.ISBN-13:978-8126556014
2. Mark Lutz, "Programming Python", 4th Edition, O'Reilly Media, 2011.ISBN-13: 978- 9350232873
3. Wesley J Chun, "Core Python Applications Programming", 3rd Edition,Pearson Education India,2015.ISBN-13:978-9332555365
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, "Data Structures and Algorithms in Python",1stEdition, Wiley India Pvt Ltd, 2016. ISBN-13: 978-8126562176.
5. ReemaThareja, "Python Programming using problem solving approach", Oxford university press, 2017

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COURSE CODE	18ECELPENE	COURSE TITLE	NANO ELECTRONICS
CREDITS	3	L-T-P	3-0-0

COURSE OUTCOMES

CO1	Ability to extend the knowledge of electronic engineering materials from a micro level to a nano scale	PO3
CO2	Ability to analyze nano materials in a quantitative manner from the perspective of physics and also in terms of the required instrumentation techniques	PO3
CO3	Ability to analyze and devise fabrication techniques at nano scale for useful applications	PO3

Unit 1

Introduction: Overview of nano-science & engineering. Development milestones in microfabrication and electronic industry. Moore's law and continued miniaturization. Classification of nano structures. Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, free electron models and energy bands, crystalline solids periodicity of crystal lattices, electronic conduction, effects of nanometer length scale, fabrication methods: Top-down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of Nano-systems.

Unit 2

Characterization: Classification, microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk, surface, spectroscopy techniques: photon, radio frequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties. Inorganic semiconductor nanostructures: Overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states.

Unit 3

Fabrication techniques: requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, colloidal quantum dots, self-assembly techniques.

Unit 4

Physical processes: modulation doping, quantum hall effect, resonant tunnelling, charging effects, ballistic carrier transport, Interband absorption, intraband absorption, light emission processes, photon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural

Unit 5

Methods of measuring properties-structure: atomic, crystallography, microscopy, spectroscopy. Properties of nanoparticals: metal nano clusters, semiconducting nanoparticles, rare gas and molecular clusters, methods of synthesis (RF, chemical, thermolysis, pulsed laser methods) Carbon nanostructures and its applications (field emission and shielding, computers fuel cells, sensors, catalysis), Self-assembling nanostructured molecular materials and devices: building blocks, principles of self-assembly, methods to prepare and pattern nanoparticles, template nanostructures, liquid crystal mesophases. Nanomagnetic materials and devices: magnetism, materials, magnetoresistance, nanomagnetism in technology, challenges facing nanomagnetism Applications: Injection lasers, quantum cascade lasers, single photon sources, biological tagging, optical memories, coulomb blockage devices, photonic structures, QWIP's NEMS, MEMS.

Text Books:

1. Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, "Nanoscale science and technology", John Wiley and sons, 2007
2. Charles P Poole, Jr.Frank J owens, "Introduction to Nanotechnology", John Wiley, Copyright 2006, Reprint 2011
3. Ed William A Goddart III, Donald W Brenner, Sergey Edward Lyshevski, Gerald J Lafrate, "Hand book of Nanoscience Engineering and Technology", CRC Press 2003

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COURSE CODE	18ECELPEML	COURSE TITLE	MACHINE LEARNING & AI
CREDITS	3	L-T-P	2-1-0

COURSE OUTCOMES

CO1	Ability to infer on the dynamics, design and performance of ML paradigms using relevant mathematical paradigms	PO3
CO2	Ability to condition, portray and model engineering systems for a gamut of ML based techniques	PO3
CO3	Ability to analyze the performance of ML techniques vis-à-vis Conventional techniques in a quantitative manner	PO2

Unit 1

Linear Models for Classification: Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models, The Laplace Approximation, Bayesian Logistic Regression, Exercises

Unit 2

Neural Networks: Feed-forward Network Functions, Network Training, Error Backpropagation, The Hessian Matrix, Regularization in Neural Networks, Mixture Density Networks, Kernel Methods, Radial Basis Function Networks, Gaussian Processes, Exercises

Unit 3

Sparse Kernel Machines: Maximum Margin Classifiers, SVMs for regression, Relevance Vector Machines, RVM for regression, RVM for classification, Exercises

Unit 4

Graphical Models: Bayesian Networks, Example: Polynomial regression, Generative models, Linear-Gaussian models, Conditional Independence, Markov Random Fields, Inference in Graphical Models, Mixture Models: K-means Clustering, Mixtures of Gaussians, An

Alternative View of EM, The EM Algorithm in General, Exercises

Unit 5

Approximate Inference: Variational Inference, Illustration: Variational Mixture of Gaussians, Variational distribution, Predictive density, Induced factorizations, Variational Linear Regression, Variational distribution, Predictive distribution, Local Variational Methods, Optimizing the variational parameters, Inference of hyperparameters, Expectation Propagation, Exercises

Text books:

1. Pattern Recognition and Machine Learning, Christopher M. Bishop
2. Machine Learning: A Probabilistic Perspective (Adaptive Computation and Machine Learning series) 1st Edition, Kevin P. Murphy

REFERENCE BOOKS:

1. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig
2. Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville
3. Machine Learning, Tom M. Mitchell
4. Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies (The MIT Press) 1st Edition, by John D. Kelleher, Brian Mac Namee, Aoife D'Arcy
5. Machine Learning: A Bayesian and Optimization Perspective (Net Developers) 1st Edition, Sergios Theodoridis

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COURSE CODE	18ECELPENS	COURSE TITLE	NETWORK SECURITY AND CRYPTOGRAPHY
CREDITS	3	L-T-P	2-1-0

COURSE OUTCOMES

CO1	Understand the basic concepts of cryptography and encrypt various types of cipher	PO3
CO2	Learn various encryption standards and design the various key distribution and management schemes	PO3
CO3	Analyze existing authentication protocols for two party communication and digital signatures	PO3
CO4	Become proficient in the application of Number theory for design of various crypto algorithms.	PO3
CO5	Ability to make an effective oral presentation and explore new ideas in a team	PO2

Unit 1

Overview: Introduction, Security Trends, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security. Classical Encryption Techniques, Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography.

Unit 2

Block Ciphers and the Data Encryption Standard: Block Cipher Principles, The Data Encryption Standard ,The Strength of DES , Differential and Linear Cryptanalysis, Block Cipher Design Principles, Multiple Encryption and Triple DES ,Block Cipher Modes of Operation, Advanced Encryption Standard ,Evaluation Criteria For AES ,The AES Cipher

Unit 3

Public Key Cryptography and Key Management: Principles of Public-Key Cryptosystems, The RSA Algorithm, Key Management, Diffie-Hellman Key Exchange.

Unit 4

Message Authentication and Digital Signature: Message integrity, Random Oracle Model, Message Authentication codes, Digital Signature Process, Services, and Attacks on Digital Signature, Digital Signature Schemes and Applications.

Unit 5

Mathematics of Cryptography: Introduction to Number Theory, Prime Numbers, Fermat's and Euler's Theorems, the Chinese Remainder Theorem, Discrete Logarithms

Text Books:

1. William Stallings, **"Cryptography and Network Security"**, 4th Edition, Pearson Education PHI

2. Behrouz A Forouzan, Debdeeep Mukhopadhyay, "**Cryptography and Network Security",**2nd Edition, McGraw Hill

3. Atul Kahate ," **Cryptography and Network Security",** 2nd edition , Tata McGraw-Hill Publishing Company Limited.

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COURSE CODE	18ECELGEDE/ 18ECDCGEDE	COURSE TITLE	DETECTION AND ESTIMATION TECHNIQUES
CREDITS	3	L-T-P	2-1-0

COURSE OUTCOMES

CO1	Acquire the concepts of detection theory, estimation theory and binary/composite hypothesis testing	PO3
CO2	Apply different techniques to perform detection of deterministic / random signals in the presence of noise	PO3
CO3	Visualize higher applications of the concept in EC engineering applications through study of relevant IEEE papers	PO2

Unit 1

Hypothesis testing: Binary hypothesis testing, MAP criteria, Bayes' risk, Neyman-Pearson theorem, multiple hypothesis tests, Performance of Binary Receivers in AWGN, Sequential Detection and Performance.

Unit 2

Signal detection with random parameters: Detection of known signals in noise, Matched filter, Performance evaluations, Composite Hypothesis Testing, Unknown Phase, Unknown Amplitude, Unknown Frequency, White and Colored Gaussian Noise for Continuous Signals, Estimator Correlator.

Unit 3

Detection of multiple hypotheses: Bayes Criterion, MAP Criterion, M-ary Detection Using Other Criteria, Signal-Space Representations, Performance of M-ary Detection Systems, Sequential Detection of Multiple Hypotheses, Linear models, Rayleigh fading sinusoid.

Unit 4

Fundamentals of estimation theory: Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems. Properties of estimators, Applications.

Text Books:

1. Harry L. Van Trees,**"Detection, Estimation, and Modulation Theory, Part I,"** John Wiley & Sons, Inc. 2001**.**

2. StevenM.kay**, "Fundamentals of Statistical signal processing, volume-1: Estimation theory".** Prentice Hall 1993**.**

3. A.Papolis and S.UnnikrishnaPillai**, "Probability, Random Variables and stochastic processes",** 4e,.The McGraw-Hill 2002**.**

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COURSE CODE	18ECELPESC	COURSE TITLE	SYSTEM ON CHIP
CREIDTS	3	L-T-P	2-1-0

COURSE OUTCOMES:

CO1	**Apply** concepts of Moore's law, CMOS scaling to understand the System on Chip with its need, evolution, challenges, goals, superiority over system on board & stacked ICs in package.	**PO3**
CO2	**Analyze** typical goals in SoC design and also inter connect architecture	**PO3**
CO3	**Design** solutions for issues at system level and issues of Hardware-Software co design	**PO3**

Unit 1

Review of Moore's law and CMOS scaling, benefits of System On Chip integration in terms of cost, power, and performance. Comparison on System on Board, System on Chip, and System-in-Package. Typical goals in SoC design cost reduction, power reduction, design effort reduction, performance maximization. Productivity gap issues and the ways to improve the gap – IP based design and design reuse.

Unit 2

System On Chip Design Process: A canonical SoC Design, SoC, Design flow, waterfall vs spiral, top down vs bottom up, Specification requirement, Types of Specification, System Design Process, System level design issues, Soft IP vs Hard IP, IP verification and Integration, Hardware-Software co design, Design for timing closure, Logic design issues, Verification strategy, On chip buses and interfaces, Low Power, Hardware Accelerators in Soc.

Unit 3

Embedded Memories, cache memories, flash memories, embedded DRAM. Topics related to cache memories. Cache coherence. MESI protocol and Directory-based coherence.

Unit 4

Interconnect architectures for SoC: Bus architecture and its limitations. Network on Chip (NOC) topologies. Mesh-based NoC. Routing in an NoC. Packet switching and wormhole routing.

Unit 5

MPSoCs: What, Why, How MPSoCs, Techniques for designing MPSoCs, Performance and flexibility for MPSoCs design

Case Study: A Low Power Open Multimedia Application Platform for 3G Wireless.

Text Books:

1. SudeepPasricha and NikilDutt,**"On-Chip Communication Architectures: System on Chip Interconnect"**, Morgan Kaufmann,Publishers © 2008.
2. Rao R. Tummala, MadhavanSwaminathan, **"Introduction to system on package sop- Miniaturization of the Entire Syste"**,McGraw-Hill, 2008.
3. James K. Peckol, **"Embedded Systems: A Contemporary Design Tool"**, Wiley Student Edition.

Reference Books:

1. Michael Keating, Pierre Bricaud, **"Reuse Methodology Manual for System on Chip designs"**, Kluwer Accademic Publishers, 2nd edition, 2008.
2. Sung-Mo Kang, Yusuf Leblebici, **"CMOS Digital Integrated Circuits"**, Tata Mcgraw- Hill, 3rd Edition.

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M. Tech- ELECTRONICS Institutional Core First Semester

RESEARCH METHODOLOGY

COURSE CODE	18ALLPICRM	TITLE	RESEARCH METHODOLOGY
CREDITS	2	L-T-P	2-0-0

COURSE OUTCOMES

CO1	Ability to write and present a substantial technical report/document	**PO2, PO1**
CO2	Able to demonstrate a degree of mastery over the area of specialization	**PO3**

Unit 1

Leaning and sources of research problem, , Objectives and Characteristics of research – Errors in selecting research problem, Research methods Vs Methodology - Types of research-Criteria of good research – Developing a research plan.

Unit 2

Investigations of a research problem - Selecting the problem - Necessity of defining the problem – Data collections-analysis- Importance of literature review in defining a problem - Survey of literature -Necessary instrumentations

Unit 3

How to write paper-conference articles-poster preparation, thesis report writing, inclusion of references, journal reviewing process, journal selection process, filling about journal template, developing effective research proposal-plagiarism-research ethics

Unit 4

Nature of Intellectual property, IPRs- Invention and Creativity - Importance and Protection of Intellectual Property Rights (IPRs) – procedure for grant of patents and patenting under PCT-types of patents-technological research and innovation- international cooperation on IP.

Unit 5

A brief summary: Patents-Copyrights-Trademarks, patent rights-licensing and transfer of technology-patent databases-case studies on IPR-Geographical indications-new developments in IPR-protection of IPR rights

REFERENCE BOOKS:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications.
5. Subbarau NR-Handbook of Intellectual property law and practise- S Viswanathan Printers and Publishing Private Limited 1998

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COURSE CODE	18ECELIEIT	COURSE TITLE	INTERNET OF THINGS
CREDITS	4	L-T-P	4-0-0

COURSE OUTCOMES

CO1	Interpret the impact and challenges posed by IoT networks leading to new architectural models for various case studies	**PO3**
CO2	Compare and contrast the deployment of smart objects and the technologies to connect them to network.	**PO3**
CO3	Elaborate the need for Data Analytics in IoT.	**PO3**

Unit 1

Introduction: What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

Unit 2

Smart Objects: What Are Smart Objects? Where do Smart Objects come from? Smart Object Hardware and Software, Communication Mechanisms for Smart Objects.

Unit 3

IP Protocol Architecture, Why IP for Smart Objects? IPv6 for Smart Object Networks and the Internet of Things, The 6LoWPAN Adaptation Layer, The IP for Smart Object Alliance, Non-IP Technology

Unit 4

Data and Analytics for IoT: An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and

FAIR, The Phased Application of Security in an Operational Environment

Unit 5

IoT in Industry: Smart Cities and Urban Networks, Transportation, Structural Health Monitoring, Home Automation.

Textbooks

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
2. Jean-Philippe Vasseur,Adam Dunkels,"Interconnecting SmartObjects with IPThe Next Internet"Morgan Kaufmann Publishers,2010 Elsevier.

References

1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1 stEdition, VPT, 2014. (ISBN: 978-8173719547)
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224)

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COURSE CODE	18ECELPCIN	COURSE TITLE	INTERNSHIP
CREDITS	09	L-T-P	---

COURSE OUTCOMES

CO1	Able to develop a sound theoretical and practical knowledge of new technologies.	**PO3**
CO2	Able to develop domain specific problem solving and critical thinking skills	**PO3**
CO3	Able to develop individual responsibility towards their internship goal as well as participate as an effective team member	**PO3**
CO4	Able to develop professional work culture & practices	**PO3**
CO5	Able to develop effective presentation & communication skills, and create proper documentation of the work	**PO2**

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COURSE CODE	18ECELPWP1	COURSE TITLE	PROJECT WORK (I-PHASE)
CREDITS	08	L-T-P	---

COURSE OUTCOMES

CO1	Identify a suitable project, making use of the technical and engineering knowledge gained from previous courses with the awareness of impact of technology on the Society and their ethical responsibilities	**PO3**
CO2	Collect and disseminate information related to the selected project within given time frame.	**PO1**
CO3	Communicate technical and general information by means of oral as well as written Presentation skills with professionalism.	**PO2**

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COURSE CODE	18ECELPWP2	COURSE TITLE	PROJECT WORK (PHASE 2)
CREDITS	20	L-T-P	---

COURSE OUTCOMES

CO1	Identify the modern tools required for the implementation of the project.	**PO3**
CO2	Design, examine critically and implement or develop a prototype for the identified problem during Phase I	**PO1**
CO3	Communicate technical information by means of oral as well as written presentation skills with professionalism and engage in life-long learning.	**PO2**

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COURSE CODE	18ECELSR01	COURSE TITLE	TECHNICAL SEMINAR-1
CREDITS	02	L-T-P	-

COURSE OUTCOMES

CO1	Identify the problem through literature survey by applying depth knowledge of the chosen domain	**PO3, PO1**
CO2	Analyze, synthesize and conceptualize the identified problem	**PO3**
CO3	Communicate clearly, write effective reports and make effective presentations following the professional code of conduct and ethics	**PO2**
CO4	Comprehensively study the domains and reflect the same towards the future enhancements of the work	**PO2**

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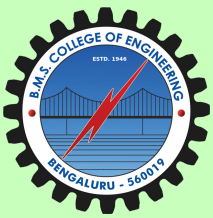
COURSE CODE	18ECELSR02	COURSE TITLE	TECHNICAL SEMINAR-2
CREDITS	02	L-T-P	---

COURSE OUTCOMES

CO1	Identify the problem through literature survey by applying depth knowledge of the chosen domain	**PO3, PO1**
CO2	Analyze, synthesize and conceptualize the identified problem	**PO3**
CO3	Communicate clearly, write effective reports and make effective presentations following the professional code of conduct and ethics	**PO2**
CO4	Comprehensively study the domains and reflect the same towards the future enhancements of the work	**PO2**



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