PimpriChinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

AnAutonomousInstituteApprovedbyAICTEANdAffiliAtedtoSPPU,Pune

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Curriculum Structure and Syllabus

of

M. Tech. (E&TC)-VLSI and Embedded Systems

(Course 2020)

(Updated with minor changes from 23-24)

VISION AND MISSION OF INSTITUTE

Institute Vision:

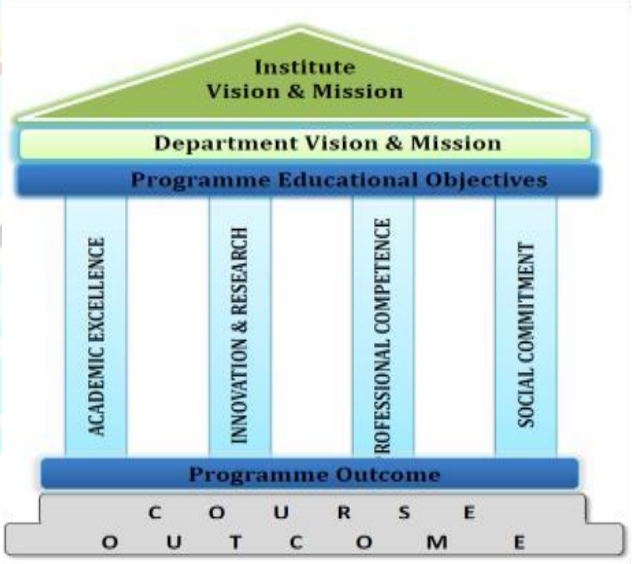
To be one of the top 100 Engineering Institutes of India in coming five years by offering exemplarily Ethical, Sustainable and Value Added Quality Education through a matching ecosystem for building successful careers.

Institute Mission:

1. Serving the needs of the society at large through establishment of a state-of-art Engineering Institute
2. Imparting right Attitude, Skills, Knowledge for self-sustenance through Quality Education
3. Creating globally competent and Sensible engineers, researchers and entrepreneurs with an ability to think and act independently in demanding situations

Quality Policy

We at PCCOE are committed to impart Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders. We shall strive for academic excellence, professional competence and social commitment in fine blend with innovation and research. We shall achieve this by establishing and strengthening state-of- the-art Engineering and Management Institute through continual improvement in effective implementation of Quality ManagementSystem.



INDEX:

ABBREVIATIONS

Abbreviations	Course Full Name
PCC	**Professional C**ore **C**ourse
PEC	**P**rofessional **E**lective **C**ourse
OEC#	**O**pen **E**lective **C**ourse
PROJ	**Proj**ect, Mini / Minor **Proj**ects, Integrated **Proj**ects
SEM	**Sem**inar
INTR	**Inter**nship
LS*	**L**ife **S**kill
AUDIT*	**A**udit **C**ourse
MOOC	**Massive Open Online Courses**
h	**Hours**

Note : * Indicates that these courses are at institute level # The Course offered by the other department

CURRICULUM STRUCTURE

STRUCTUREFOR1ST YEARM.TECH(E&TC-VLSIANDEMBEDDEDSYSTEMS)

SEMESTER –I

M.TechStructure		Sem-I	Teaching Scheme				Examination Scheme					
Course Code	**Course Type**	**Course Name**	**L**	**P**	**H**	**CR**	**IE1**	**IE2**	**ETE**	**TW**	**OR**	**Total**
MET1401	PCC	Research Methodology & IPR	3	-	3	3	20	30	50	-	-	100
MET1402	PCC	CMOS VLSI Design	3	-	3	3	20	30	50	-	-	100
MET1403	PCC	Embedded System Design	3	-	3	3	20	30	50	-	-	100
MET 1404	PCC	Professional Core Lab-I	-	2	2	1	-	-	-	50	50	100
MET 1501	PEC	Professional Elective-I	3	-	3	3	20	30	50	-	-	100
MET 1502	PEC	Professional Elective-II	3	-	3	3	20	30	50	-	-	100
MET1503	PEC	Professional Elective Lab-I	-	2	2	1	-	-	-	50	50	100
**	OEC	Open Elective-I	2	-	2	2	20	-	30	-	-	50
MET1405	PCC	Skill Development Lab – I (Software Skill)	-	2	2	1	-	-	-	50	-	50
M_1961	Audit	Audit Course – I	**1**	-	**1**	-	-	-	-	-	-	-
		Total	**18**	**6**	**24**	**20**	**120**	**150**	**280**	**150**	**100**	**800**

STRUCTUREFOR1ST YEARM.TECH(E&TC-VLSIANDEMBEDDEDSYSTEMS)

SEMESTER –II

M.TechStructure		Sem-II	Teaching Scheme				Examination Scheme					
Course Code	**Course Type**	**Course Name**	**L**	**P**	**H**	**CR**	**IE1**	**IE2**	**ETE**	**TW**	**OR**	**Total**
MET2406	PCC	Advanced CMOS Design	3	-	3	3	20	30	50	-	-	100
MET2407	PCC	Embedded System Programming and Real time OS	3	-	3	3	20	30	50	-	-	100
MET2408	PCC	Professional Core Lab-II	-	2	2	1	-	-	-	50	50	100
MET2504	PEC	Professional Elective-III	3	-	3	3	20	30	50	-	-	100
MET2505	PEC	Professional Elective-IV	3	-	3	3	20	30	50	-	-	100
MET2506	PEC	Professional Elective Lab -II	-	2	2	1	-	-	-	50	50	100
**	OEC	Open Elective –II	2	-	2	2	20	-	30	-	-	50
MET2701	PROJ	Integrated Mini-Project	-	6	6	3	-	50	-		50	100
M_2101	HSMC	Skill Development Lab – II (Oral & Written Communication)	-	2	2	1	-	-	-	50	-	50
M_2962	Audit	Audit Course –II	1	-	1	-	-	-	-	-	-	-
		Total	**15**	**12**	**27**	**20**	**100**	**170**	**230**	**150**	**150**	**800**

STRUCTUREFORIINDYEARM.TECH(E&TC-VLSIANDEMBEDDEDSYSTEMS)

SEMESTER-III

M.TechStructure		Sem – III	TEACHING SCHEME				EXAMINATION SCHEME					
Course Code	**Course Type**	**Courses**	**L**	**P**	**H**	**CR**	**IE-1**	**IE-2**	**ETE**	**TW**	**OR**	**TOTAL**
MET3702	PROJ	Dissertation Phase - I [Company/ In-house project]	-	20	20	10	-	-	-	100	100	200
MET3703	SEM	Seminar	-	04	04	02	-	-	-	50	50	100
MET3801	INTR	Internship [Company/ In-house project] /	-	04	04	02	-	-	-	100	-	100
OR												
MET3981	MOOC	MOOC's / Entrepreneurship	-	04	04	02	-	-	-	100	-	100
		Total	**-**	**28**	**28**	**14**	**-**	**-**	**-**	**250**	**150**	**400**

*Internship**: -It may be in summer/winter vacation or within semester at least for three months, evaluation after fourth semester**

SEMESTER-IV

M.TechStructure		Sem –IV	TEACHING SCHEME				EXAMINATION SCHEME					
Course Code	**Course Type**	**Courses**	**L**	**P**	**H**	**CR**	**IE-1**	**IE-2**	**ETE**	**TW**	**OR**	**TOTAL**
MET4704	PROJ	Dissertation Phase - II [Company/ In-house project]	-	24	24	12	-	-	-	200	200	400
MET4982	MOOC	MOOC's	-	4	4	2	-	-	-	100	-	100
		Total	**-**	**28**	**28**	**14**	**-**	**-**	**-**	**300**	**200**	**500**

Abbr: Course Abbreviation; **L**- Lecture; **P**- Practical; **H**- Hours; **CR**- Credits; **IE-1** – Internal Evaluation-1; **IE-2** – Internal Evaluation-2; **ETE** – End Term Examination; **TW** – Term Work; **OR** – Oral Exam

** Course code of the selected open elective by student

LIST OF PROGRAM ELECTIVE

	Elective-I		**Elective-II**
MET1501A	Advanced Signal Processing and Processor Design	**MET1502A**	System on Chip (HW-SW Co-design)
MET1501B	Microelectronic Devices and Modeling	**MET1502B**	Embedded Processor Architecture and Design
MET1501C	CAD Algorithms for VLSI Design	**MET1502C**	System Design with Embedded Linux
MET1501D	Embedded Networking	**MET1502D**	Embedded System Applications
MET1501E	Advanced Devices and modeling for VLSI		

	Elective-III		**Elective-IV**
MET2504A	Reconfigurable Computing	**MET2505A**	Embedded System for Automotive Applications
MET2504B	IOT in Embedded systems	**MET2505B**	Embedded Systems in Biomedical Applications
MET2504C	ASIC Design	**MET2505C**	VLSI Testing and Design for Testability
MET2504D	Hardware and Software Co-design	**MET2505D**	System Verilog for Verification

Syllabus of F.Y.M.Tech Courses (Approved by E&TC BOS)

(Course 2020)

Course Syllabus

Semester-I

Program:	M. Tech. (E&TC)-VLSI and Embedded Systems			Semester: I		
Course:	Research Methodology and IPR			Code: MET1401		
Teaching Scheme/ Week			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of

Project and seminars in undergraduate**Is Essential**

Objectives:

1. To select and define appropriate research problem and parameters with appropriate methodology.
2. To understand statistical techniques for the specific perspective data in an appropriate manner.
3. To make predictions and decisions for the data set using open-source software.
4. To understand the mathematical modeling and its predicting capability.
5. To learn the various steps in research writing and publication process
6. To introduce fundamental aspects of Intellectual property Rights

Outcomes:

After learning the course, the students should be able to:

1. Define a research problem and use appropriate research methodology
2. Examine data using different hypothesis tests and make conclusions about acceptance or rejection of sample data.
3. Analyze numerical data, using standard procedures of probability theory to predict the performance.
4. Develop a mathematical model and analyze the prediction capabilities
5. Write a research paper and research proposal.
6. Write a concept note and prepare to file an IP.

Detailed Syllabus:

	Description	Duration (Hrs)
1.	**Research Problem and Research Design** Objectives, Motivation, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Criteria of Good Research Definition and Feasibility study of research problem, Sources of research problem, Meaning of Hypothesis, Characteristics of Hypothesis, Errors in selecting a research problem, Concept & need of research design	6
2.	**Applied Statistics** Measures of Variability: Standard Deviation, variance, Quartiles, Interquartile Range Inferential Statistics: Statistical Significance (p values), Pearson's r test, t- test, Chi square test, ANOVA (Analysis of variance)	8
3.	**Probability** Sampling, Types of Sampling, Probability Distribution: Binomial Distribution, Poisson Distribution, Normal Distribution, Case Study: Develop a model for Prediction and Decision Making for the data set using open-source software	8
4.	**Mathematical Modeling and prediction of performance** Types of Modeling, Types of solutions to mathematical models, Steps in Setting up a computer model to predict performance of experimental system, Validation of results, Multi-scale modeling and verifying performance of process system, Nonlinear analysis of system and asymptotic analysis, Sensitivity analysis.	8
1.	**Research Report writing and Publication** Research Report: Dissemination of research findings, outline and structure of research report, different steps and precautions while writing research report, methods and significance of	5

	referencing. Publishing Research work: Selection of suitable journal for publishing research work, Open access Vs Subscription Journals, Identifying indexing of selected journals, Impact factor of the journal, structure of research paper, Check for plagiarism of the article, Research paper submission and review process.	
2.	**Intellectual property Rights** Definition of IPR, Classification of IP, Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents. Prior Art Search, Patentability Criteria, Patent Filing Procedure, Forms and Fees, Case Study of Patent, Copyright.	**8**
	Total	**45**

Textbooks:

1. C. R. Kothari,Research Methodology: Methods and Techniques, New Age International, 2nd Edition, 1985
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 2nd Edition.,2010.
3. Ramakrishna B and Anil Kumar H S., Fundamentals of IPR, Notion Press, 2016
4. Virendra Kumar Ahuja, IPR in India, LexisNexis ButterworthsWadhwa Nagpur, 2017

Reference Books:

1. Stuart Melville and Wayne Goddard, " Research methodology: An Introduction for Science & Engineering students"Juta Education, 1996
2. S.D. Sharma, Operational Research, Kadar Nath Ram Nath& Co
3. Wayne Goddard and Stuart Melville, Research Methodology: An Introduction, Juta and Company Ltd, 2004

Program:	**M. Tech (VLSI & Embedded Systems)**				**Semester:**	**I**
Course:	**CMOS VLSI Design**				**Code:**	**MET1402**
Teaching Scheme				**Evaluation Scheme**		
Lecture	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior knowledge of

Basic understanding of MOSFETs is Essential**.**

Objectives:

1. Explain the fundamentals of CMOS Technology and its various performance parameters.
2. Explore the techniques of designing digital VLSI systems.
3. Describe design concepts of data path and memory subsystems

Outcomes: After learning the course the students should be able to:

1. To understand basic MOS transistor theory and effects of scaling.
2. To estimate the delay of logic networks and also analyse logical efforts
3. To compare combinational circuit design using CMOS, transmission gate and pass transistor logic.
4. To prepare the layout and estimate the area on chip of combinational circuits using CMOS
5. To analyse sequential circuits and issues related to it.
6. To understand design principles and techniques of data path and memory subsystems

DetailedSyllabus:

Unit	**Description**	**Duration** (Hrs)
1.	**MOS Transistor Theory and Analysis:** Basic Electrical Properties of MOS Circuits: Ids-Vds Relationships, MOS Transistor Threshold Voltage Vth, MOS Capacitance models, MOS GateCapacitanceModel,MOSDiffusionCapacitanceModel,Technologyscaling,Lambdaparameter, non-ideal I-V Effects CMOS Inverter Transfer Characteristics and Analysis and Design, Latch up in CMOS Circuits.	8
2.	**CMOS Performance Parameters:** Static, dynamic and short circuit power dissipations, Propagation delay, Power delay product, Fan in, fan out and dependencies. Delay Estimation**:** RC Delay Models, Linear Delay Model, Logical Effort, Parasitic Delay. Logical Effort and Transistor Sizing: Delayin a Logic Gate, Delayin Multistage Logic Networks.	8
3.	**Logic Design-I:** Static CMOS Logic: Inverter, NAND Gate, NOR Gate, Design of Combinational logic, Multiplexers, decoders, Compound Gates, Pass Transistors and Transmission Gates, Tristate, StickDiagram and Layout Design,Designcalculationsforcombinationallogicandactiveareaonchip;Hazards,sourcesand mitigation techniques, Design Examples	8
4.	**Logic Design – II** Timing Metrics for Sequential Circuits, Static Latchesand Registers, Dynamic Transmission-Gate Based Edge-triggered Registers, Pulse Registers, Sense-Amplifier Based Registers, Meta-stability issues and solutions; Design Examples,	8
5.	**DatapathSubsystems:**Adders,Multipliers,Comparators,ParityGenerators,RegistersandCounters	7
6.	**Memory / Array Subsystems:** Introduction to SRAM, DRAM, ROM, Serial access memories; CAM	6
	Total	**45**

Text Books:

1. NeilH. Weste, David Money,“ CMOS VLSI Design: Acircuit&SystemPerspective",3rdEdition Pearson Publication.
2. M.Rabaey, A .Chandrakasanand B.Nikolic, Digital Integrated Circuits: A Design Perspective, Pearson.

Reference Books:

1. S-M. Kangand Y.Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, Third Edition, McGraw-Hill.
2. WayneWolf,“ Modern VLSI Design", third edition 2ndEdition,PrenticeHall,1998.

Program:	**M. Tech. (E&TC)-VLSI and Embedded Systems**				**Semester : I**	
Course :	**Embedded System Design**				**Code :**	MET1403
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IEI**	**IEII**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior knowledge of

Microcontroller Applications and Advanced Microprocessors **Is Essential.**

Objectives :

1. To explain need and application of ARM Microprocessors in embedded system.
2. To introduce of basics of the architecture of ARM series microprocessor
3. To explore architecture and features of typical ARM7& ARM Cortex Processors.
4. To improve the skills related interfacing of real world input and output devices and embedded communication systems.

Outcomes:

After learning the course the students should be able to:

1. Apply knowledge about the basic functions of embedded systems.
2. Understand evolution of ARM from ARM7 to ARM11.
3. Interface the advanced peripherals to ARM based microcontroller
4. Design real time applications using ARM Cortex and peripherals.
5. Apply knowledge to define attributes of functional units of serial protocol for interfacing.
6. Evaluate case studies to explore design parameters and its selection in embedded applications.

Detailed Syllabus:

Unit	**Description**	**Duration** (Hrs)
1.	**Introduction to Embedded Systems** Introduction to Embedded Systems, Architecture of Embedded System, Design Methodology, Design Metrics, General Purpose Processor, and System On chip. **Embedded system design and development:** Embedded system design**,** Life-Cycle Models, Problem solving, The design process, Requirement identification, Formulation of requirements specification. Development tools.	**8**
2.	**ARM7, ARM9, ARM11 Processors** Introduction to ARM processors and its versions, ARM7, ARM9 & ARM11 features, advantages & suitability in embedded application, registers, CPSR, SPSR, ARM and RISC design philosophy, ARM7 data flow model, programmers model, modes of operations	**6**
3.	**ARM7 Based Microcontroller** ARM7 Based Microcontroller LPC2148: Features, Architecture (Block Diagram and Its Description), System Control Block (PLL and VPB divider) , Memory Map, GPIO, Pin Connect Block, timer, Instruction set, programming in assembly language	**8**

4.	**Embedded Serial Communication:** Study of basic communication protocols like SPI, SCI (RS232, RS485), I2C, 10 CAN, USB (v2.0), Bluetooth, Zig-Bee, Wireless sensor network	**8**
5.	**Advanced embedded architectures (Cortex-M3/M4)** Introduction to ARM CORTEX series, Design Philosophy, processors series, versions, features and applications. CMSIS standard for ARM Cortex. Survey of CORTEX M3/M4 based controllers. ARM-CM3 Based Microcontroller LPC1768: Features, Architecture (Block Diagram &its description), System Control, Clock & Power Control, GPIO, Pin Connect Block, interfacing with RGB LED, Seven Segment, TFT Display, MOTOR control using PWM.	**9**
6.	**Embedded System Design Case Studies** Automated Meter Reading Systems (AMR), Digital Camera, Multimedia System, Electronic Control Unit (ECU) of Car and Medical Instrumentation.	**6**
	Total	**45**

Text Books:

1. David E. Simon, "An Embedded Software Primer",Perason Education,2003.
2. Frank Vahid and Tony Givargis, "Embedded System Design: A Unified Hardware/Software Introduction", Wiley Publication, 2006.

Reference Books:

1. Noergaard Tammy, "Embedded Systems Architecture", Elsevier Publication, 2005.
2. Shibu," Introduction to Embedded Systems", Tata McGraw-Hill, 2016
3. Rajkamal, Embedded Systems: Architecture, Programming and Design, Tata McGraw-Hill Education, 2008
4. Joseph Yiu, The Definitive Guide to the ARM Cortex-M3. Newnes, 2007.

Program:	M.Tech (E&TC)-VLSI and Embedded Systems			Semester :	I	
Course :	Professional Core Lab-I			Code :	MET 1404	
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	50

Prior knowledge of

Front End Tools and Back End Tools basics, C Language basics and Interfacing basics**Is Essential**

Objectives:

1. To understand the significance of CMOS design inVLSI
2. To learn Hardware and Software design tools
3. To design Embedded Systems for real time application
4. To learn ARM 7 architecture and its programming concepts

Outcomes: After learning the course the students should be able to:

1. design basic logic circuits using CMOStechnology
2. Interface the advanced peripherals to ARM based microcontroller
3. Carry out programming in Embedded programming in C,Keil

Guidelines :

1. Total experiments to be conducted are **8 experiments of 30 hours**

Detailed Syllabus:

Part A: CMOS VLSI Design (ANY Three)

Expt.	Description
1.	To design, prepare layout and simulate MOS transistor and CMOS Inverter for the given specifications of load capacitance, propagation delay, power dissipation, foundry etc. Also observe the impact of variation of technology parameters like length, oxide thickness on the performance of MOS transistor.
2.	To design CMOS logic for F = A + B (C + D) + EFG and prepare layout. Assume suitable capacitive load & foundry. Measure TR, TF& TPD.
3.	Design and simulate combinational circuits (adder/multiplexer/decoders) using CMOS and Transmission Gate.
4.	Design and simulate sequential circuits (FFs/latches/registers)using CMOS and Transmission Gate.

Part B: Embedded System Design (ANY Three)

Expt.	Description
1.	Interfacing LPC2148 with GLCD to display image on it
2.	Interfacing EEPROM to LPC2148 using I2C protocol
3.	Interfacing USB & CAN of LPC 1768.
4.	Generate the square wave and use external interrupt to change the duty cycle of the square wave. (use LPC 2148)

Text Books:

1. Neil H. Weste, David Money, “CMOS VLSI Design: A circuit & System Perspective", Pearson Publication.
2. M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits: A Design Perspective, Pearson.
3. David E.Simon, “An Embedded Software Primer”, Pearson Education,2003.

Reference Books:

1. S-M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, Third Edition, McGraw-Hill.
2. Wayne Wolf, “Modern VLSI Design ", 2nd Edition, Prentice Hall,1998.
3. Noergaard Tammy, “Embedded Systems Architecture”, ElsevierPublication.

Program: M.Tech (E&TC)-VLSI and Embedded Systems				Semester : I		
Course : Advanced Signal Processing and Processor Design				Code : MET1501A		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of
Digital Signal Processing is essential

Objectives:
Faculty need to:

1. Provide complete overview of Digital Signal Processing with conceptual clarity.
2. Explain, assign problems and demonstrate the fundamentals of Multirate Digital Signal Processing and filter banks
3. Outline the fundamentals and Multi resolution formulation of Wavelet Transform.
4. Help in developing the foundation of Adaptive filters for fixed- and floating-point implementations.
5. Illustrate and demonstrate different applications of Digital Signal Processing.
6. Explain and analyze fixed- and floating-point Digital Signal Processors.

Outcomes:
On completion of the course, student will be able to:

1. Apply the knowledge of mathematics, science and engineering to analysis of Digital Signal Processing.
2. Design multi rate signal processing of signals throughsystems.
3. Design system using WaveletTransform.
4. Design Adaptive filters for fixed- and floating-pointprocessors.
5. Analyze and apply Digital Signal Processing in differentareas.
6. Implement the applications using Digital SignalProcessors.

Detailed Syllabus:

Unit	Description	Duration (Hrs)
1.	**UNIT–I: DSP Fundamentals** Overview of DSP Fundamental: Elements of Digital Signal Processing System, Advantages of Digital over Analog Signal Processing, Convolution and Correlation, Estimation of Time Bandwidth product for different signals.	8
2.	**UNIT–II: Multirate Digital Signal Processing & Filter banks** Multirate Digital Signal Processing: Introduction, Decimation, Interpolation, Sampling rate Conversion by a rational factor, Filter design and implementation for Sampling - Rate Conversion: Polyphase Filter Structure, Multirate Filter banks: Maximally decimated Filter Banks, Errors created in QMF banks, Simple Alias free QMF System.	8
3.	**UNIT–III: Wavelet Transform** Introduction to Wavelets, wavelets and wavelet expansion systems, Discrete Wavelet Transform, Multiresolution formulation of wavelet systems, Haar wavelet and other wavelet representations, scaling functions, Wavelet functions, Parseval's Theorem	8
4.	**UNIT-IV: Adaptive Filters** Introduction to Adaptive Filters, Adaptive Filter Structures and Algorithms, Properties and applications, Fixed and Floating-point implementations.	6
5.	**UNIT–V: Applications of DSP** Speech Processing, Digital Radio, Digital Television, Radar, Biomedical signal Processing: Electrocardiogram, Electroencephalogram, Electromyogram.	7
6.	**UNIT-VI: Digital Signal Processor** Digital Signal Processor Architectures: Introduction, Central Processing Unit operations, Memory Configurations, Peripherals andInput/output. Fixed-Point Digital Signal Processors: Introduction, TMS320C54x Floating-Point Digital Signal Processors: Introduction, TMS320C67x	**8**
	Total	**45**

Text Books:

1. John G. Proakis, Digital Signal Processing Principles: Algorithms and Applications, PHI, Third Edition2002.
2. Glenn Zelniker, Fred J. Taylor., Advanced Digital Signal Processing: Theory and Applications, Tenth Edition, 2019
3. Simon Haykin, "Adaptive Filter Theory", Prentice Hall, Third Edition, 2014
4. M.Kuo, Woon-Seng Gan, Digital Signal Processors Architectures, Implementations and Applications, Pearson Education, 2000

Reference Books:

1. S Salivahanan. A Vallavaraj C. Gnanapriya, Digital Signal Processing, TMH, Second Edition 2001.
2. Sanjit K. Mitra, Digital Signal Processing: A computer-based Approach, Mc-Graw Hill, SecondEdition, 2000
3. Lourens R RebinarandBernold, Theory and Applications of Digital Signal Processing –Prentice-Hall of India, 2006.
4. KayvanNajarian , Robert Splinter Biomedical Signal and Image Processing, CRCpress, 2013.

Program:	**M. Tech(VLSI & Embedded Systems)**				**Semester:**	**I**
Course:	**Microelectronic Devices and Modelling**				**Code:**	**MET1501B**
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior knowledge of
Basics of Electronics and Electrical, Digital Electronics**Is Essential.**

Objectives:

1. To introduce CMOS device physics and relevant parameters
2. To develop the concept of device modeling
3. To model and implement the devices from basic characteristics to performance evaluation

Outcomes:
After learning the course the students should be able to:

1. Understand basic models of the CMOS and Bipolar devices
2. Understand process and steps of VLSI chip fabrication
3. Understand performance analysis of fabricated chips.

Detailed Syllabus:

Unit	**Description**	**Duration** (Hrs)
2.	**Solid State Device Physics**: material Properties, Crystal structure, Energy band model, Equilibrium carrier concentrations, Drift and Diffusion mechanism, Recombination and generation of carriers, continuity equations, minority carrier diffusion equations, diffusion length quasi Fermi level concepts.	**8**
2.	**Semiconductor Junctions, p-n junctions:** Poisson's equations, qualitative and quantitative analysis of p-n junction diode, fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, reverse bias breakdown and transient response of p-n junction diode.	**8**
3.	**Bipolar Devices:** Bipolar Junction Transistors, BJT Fundamentals, Fabrication, Electrostatics, Operational considerations, Minority carrier distribution, non-ideal effects, Equivalent circuit models, Frequency limitations, switching characteristics,	**6**
4.	**Field Effect Transistors- JFET:** structure, qualitative and quantitative analysis, current-voltage characteristics, effect in real devices, high frequency and high speed issues, MOS Junctions: MOS structure, Energy band diagrams, flat band voltage, threshold voltage, Charge distributions, C-V characteristics	**8**
5.	**MOSFET :** basic operation and fabrication ; ideal MOS capacitor; effects of real surfaces; threshold voltages; output and transfer characteristics of MOSFET, effective mobility, charge sheet model, non ideal effects, oxide charges, threshold voltage considerations, short-channel effects, hot-carrier effects, advanced MOSFET structures, SPICE Models.	**8**
6.	**CMOS Fabrication Technology:** An overview of wafer fabrication, oxidation, Photo Lithography, Diffusion, Ion implantation, Metallization, Packaging, n-MOS process, n well CMOS process, p well CMOS process, Twin-Tub process, Silicon on insulator process,Bi-CMOS process.	**7**
	Total	**45**

Text Books:

1. YannisTsividis, ―Operation and Modeling of the MOS Transistor‖, Oxford University Press
2. G. Montoro, M. C. Schneider, ―MOSFET Modeling for Circuit Analysis And Design‖, World Scientific,
3. M. S. Tyagi, Introduction to Semiconductor Materials and Devices, Wiley.

Reference Books:

1. B.G. Streetman and S. Banerjee, Solid State Electronic Devices, 5th edition, Prentice Hall of India
2. Y.Taur, and T.H.Ning , Fundamentals of Modern VLSI devices , Cambridge University press
3. R. S. Muller, T. I. Kamins, ―Device Electronics for Integrated Circuits‖, John Wiley & Sons

Program: M.Tech (E&TC)-VLSI and Embedded Systems					**Semester :** I	
Course : CAD Algorithms for VLSI Design					**Code :MET1501C**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior knowledge of
Basics of VLSI Design Flow**Is Essential**

Objectives:

1. Explain the role of computer-aided design (CAD) tools in automating the design flow and providing improved productivity in VLSI systems design.
2. Explain the concepts of Physical Design Process such as partitioning, Floor-planning, Placement and Routing.
3. Describe the basic algorithms used for modelling, design synthesis, simulation and analysis of ICs.
4. Discuss the concepts of design optimization algorithms.

Outcomes:

After learning the course, the students should be able to:

1. Understand the Role of CAD in VLSI design Flow
2. Acquire Knowledge about synthesis and PLDs
3. Analyse the Synthesis concepts.
4. Analyse the partitioning and floorplanning algorithms apply it in Designing
5. Analyse the placements and routing algorithms apply it in Designing
6. Acquire Knowledge about compaction, circuit extraction and simulation

Detailed Syllabus:

Unit	**Description**	**Duration** (Hrs)
1.	**INTRODUCTION TO CAD:** VLSI Design Cycle, Physical Design Cycle, Role of CAD in digital system design, levels of design. Introduction to VLSI design methodologies and supporting CAD environment.	**8**
2.	**HDL MODELLING:** Modelling of combinational and sequential logic with HDL and synthesis , Logical design. simulation & synthesis	**8**
3.	**SYNTHESIS:** 2 level optimizer and multi level minimization, BDD,CDFG, Scheduling and allocation and binding in synthesis. Introduction to PLD and synthesis in PLDs	**8**
4.	**PARTITIONING AND FLOORPLANNING**: Basics of VLSI Physical Design flow. Circuit partitioning- Floorplanning, Pin Assignment	**8**
5.	**PLACEMENT AND ROUTING:** Placement and routing algorithms: Global and detailed routing, CTS.	**7**
6.	**CIRCUIT COMPACTION & EXTRACTION:** Design Rule-verification, Circuit Compaction; Circuit Extraction and post layout simulation. Deep sub-micron issues; interconnects modeling and synthesis.	**6**
	Total	**45**

Text Books:

1. Gerez, Sabih H., "Algorithms for VLSI Design Automation", John Wiley & Sons, 2006.
2. Sherwani, Naveed A., "Algorithms for VLSI Physical Design Automation",Kluwer Academic Publishers, 1999.

Reference Books:

1. Sait, S. M. and Youssef, H. VLSI Physical design automation. IEEE press, 1995.
2. Sarrafzadeh, M. and Wong, C. K. An introduction to VLSI physical design, Mc Graw Hill, 1996.
3. Brown, S. D., Francis, R. J., Rose, J. and Vranesic, Z G. Field programmable Gate arrays. Kluwer, 1992.
4. Betz, V., Rose, J. and Marquardt, A. Architecture and CAD for Deep-submicron FPGAs. Kluwer, 1999.
5. Gaynor E. Taylor, G. Russell, "Algorithmic and Knowledge Based CAD for VLSI", Peter peregrinus ltd. London.
6. Gerez, "Algorithms VLSI Design Automation", John Wiley & Sons.

Program:	**M. Tech. (E&TC)-VLSI and Embedded Systems**				**Semester :**	**I**
Course :	**Embedded Networking**				**Code :**	**MET1501D**
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IEI**	**IEII**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior Knowledge of
Microcontrollers, Microprocessors Programming language 'C', Embedded C**is essential.**

Objectives: To impart knowledge on
1. _ Serial and parallel communication protocols
2. _ Application Development using USB and CAN bus for PIC microcontrollers
3. _ Application development using Embedded Ethernet for Rabbit processors.
4. _ Wireless sensor network communication protocols.

Outcomes:
After learning the course the students should be able to:
1. Select Protocols for Network Related Application
2. Interface USB and CAN for real time applications.
3. Program and Interface CAN based communication protocol.
4. Compare Embedded Ethernet protocols for embedded and IoT systems
5. Apply knowledge of wireless sensor networks for various applications.
6. Explore the knowledge of web based networking for IoT based application or fro cloud computing.

Detailed Syllabus:

Unit	**Description**	**Duration** (Hrs)
1.	**UNIT I EMBEDDED COMMUNICATION PROTOCOLS** Embedded Networking: Introduction–Serial / Parallel Communication–Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols - Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming -ISA/PCI Bus protocols – Firewire	**8**
2.	**UNIT - II USB AND CAN BUS** USB bus – Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets –Data flow types –Enumeration –Descriptors –Microcontroller USB Interface, CAN Bus – Introduction - Frames –Bit stuffing –Types of errors – Nominal Bit Timing	**8**
3.	**UNIT III CONTROLLER AREA NETWORK** Controller Area Network – Underlying Technology, CAN Overview – Selecting a CAN Controller – CAN development tools. Implementing CAN open Communication layout and requirements – Comparison of implementation methods – Micro CAN open – CAN open source code – Conformance test – Entire design life cycle.	**7**
4.	**UNIT - IV EMBEDDED ETHERNET** Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure.	**6**
5.	**UNIT - V WIRELESS EMBEDDED NETWORKING** Wireless sensor networks – Introduction – Applications – Network Topology – Localization – Time Synchronization - Energy efficient MAC protocols –SMAC – Energy Efficient and robust routing – Data Centric routing	**8**
6.	**UNIT – VI INTERNET/WEB AND NETWORKING BASICS FOR IOT:** OSI Model, Data transfer referred with OSI Model, IP Addressing, Point to Point Data transfer, Point to Multi Point Data transfer & Network Topologies, Sub-netting, Network Topologies referred with Web, Introduction to Web Servers, Introduction to Cloud Computing	**8**
	Total	**45**

Text Books:
1. Frank Vahid, Givargis "Embedded Systems Design: A Unified Hardware/Software Introduction", Wiley Publications

2. Bhaskar Krishnamachari, “Networking wireless sensors”, Cambridge press 2005
3. GlafP.Feiffer, Andrew Ayre and Christian Keyold, “Embedded networking with CAN and CAN open”, Embedded System Academy 2005.

Reference Books:

1. Jan Axelson, ‘Parallel Port Complete’, Penram publications
2. Jan Axelson ‘Embedded Ethernet and Internet Complete’, Penram publications.
3. Tanenbaum, Andrew “Computer Networks” 4th Edition , Pearson Education Pte. Ltd., Delhi,
4. Stallings, William, “Data and Computer Communications” 6th Edition, Pearson Education Pte., Ltd., Delhi,

Program:	**M. Tech(VLSI & Embedded Systems)**				**Semester:**	**I**
Course:	**Advanced Devices and modelling for VLSI**				**Code:**	**MET1501E**
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior knowledge of
Electron Devices , Basics of Physics & Modeling of semiconductor Devices **Is Essential**

Objectives:

1. Make projections about CMOS device scaling and how it affects circuit/system performance.
2. Recognize the relevant device physics that underlies CMOS device design.
3. Go to a conference or read a journal article about CMOS devices and use the knowledge obtained in this course to understand the material.
4. Obtain necessary skills to explore the research space of state-of-the-art VLSI technology

Outcomes:
After learning the course, the students should be able to:

1. To Challenges in CMOS and Scaling
2. To understand the overall limitations of Nanoscale MOSFETs.
3. To gain the idea about Silicon-on- Insulator (SOI) devices and its structures and modelling.
4. To Develop of fundamental concepts on IMOSFETs, TFETs, SBTFETs, CNTFET, OFET etc..
5. To gain knowledge about upcoming New devices
6. Introduction to quantum computing and devices.

Detailed Syllabus:

Unit	**Description**	**Duration H**
1.	**Challenges In CMOS:**Material ,Geometry/ BEYOND CMOS SCALING ,New Memory Devices, Speed/ Bandwidth ,ITRS Roadmap ,Energy Efficiency.2	**8**
2.	**Review Of Long Channel MOSFETS And Nanoscale MOSFET**: Limitations Of Nanoscale MOSFETS: Subthreshold Leakage, Threshold Voltage Variation, Mobility Degradation, Hot Carrier Effects, Source Drain Tunnelling, Parasitic Resistance And Capacitance, Reverse Biased Junction Leakage Current Etc2	**8**
3.	**Advanced MOSFETS:** Silicon-On-Insulator (SOI) Mosfets: Fully Depleted (FD) SOI, Partially Depleted (PD) SOI, Junction Less SOI.1,2	**6**
4.	**Promising Nanodevices Beyond CMOS :** Impact-Ionization Mosfets (IMOSFETS); Tunnel FETs (TFETS); Schottky-Barrier Fets (SBTFETS); Cabron Nanotube-Fets (CNTFETS); Organic Fets(OFETS)3	**7**
5.	**Emerging Logic Devices:** Introduction To Single Electron Transistor , Spin Fet, Nanotube Devices And Molecular Devices	**8**
6.	**Emerging Logic Devices:**IntroductionTo Neuromorphic Computing, Quantum Computing And QUANTUM CELLULAR AUTOMATA	**8**
	Total	**45**

Text Books:

1. Dr. D. Nagchoudhuri, Microelectronic Devices, Pearson Education India.
2. S. M. Sze and K. K. Ng, Physics of Semiconductor Devices, Third Edition, Wiley, 2006.
3. Jean-Pierre Colinge (Ed), FinFETs and Other Multi-Gate Transistors, Springer, 2008

Reference Books:

1. S. D. Brotherton, Introduction to Thin Film Transistors:Physics and Technology of TFTs, Springer,2013

Program: M.Tech (E&TC)-VLSI and Embedded Systems				Semester : I		
Course : System on Chip (HW-SW Co- design)				Code : MET1502A		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior Knowledge of
Digital circuit design and Programming language 'C'**is essential.**

Objectives:

1. To explain the System Architecture and Processor Architecture, Processor, Micro Architecture and approach for a SoC Design
2. To provide knowledge of Hardware and Software Design flow of SoC Design
3. To demonstrate use of Verilog for design of SoC based real time application

Outcomes:
After learning the course, the students should be able to:

1. Understand concept of system on chip and significance of SoC design and Modelling.
2. Design FSMD and Micro-programmed architectures for digital applications.
3. Analyze the performance measures of SoC circuits and processor architectures.
4. Analyze the impact of Platform-Centric Soc Design Approach.
5. Understand recent trends in Soc Prototyping, Testing and Verification
6. Design digital circuits, FSMD and Micro-programmed architectures using Verilog programming.

Detailed Syllabus:

Unit	Description	Duration (Hrs)
1.	**Basic Concepts of SoC:** The nature of hardware and software, data flow modelling and implementation, the need for concurrent models, analyzing synchronous data flow graphs, control flow modelling and the limitations of data flow models.	8
2.	**FSM Datapath and Controller :** Software and hardware implementation of data flow, analysis of control flow and data flow, Finite State Machine with data-path, cycle based bit parallel hardware, hardware model, FSM Data-path (FSMD), limitations of FSMD. **Micro-programmed Architecture:** Micro-programmed : control, encoding, data- path, Micro-programmed machine implementation, SOC modelling, hardware/software interfaces.	9
3.	**Processor Architectures:** Basic concepts in Processor Architecture, More Robust Processors such as Vector Processors, VLIW Processors and Superscalar Processors, Processor Selection for SOC, Memory Design. A SOC controller for digital still camera, portable multimedia system, SoC Platforms OMAP 137, PSoC 3 and PSoC 5	6
4.	**Platform-Centric Soc Design Methodology:** Introduction To Platforms, Platform-Based Design For Embedded Soc Systems, Platform-Centric Soc Design Approach, Comparison With Current Approaches,	6
5.	**Soc Prototyping And Verification :** Soft Prototyping: Soc Design Flow, Transaction Level Modeling, Hw-Sw Co-Verification, HDL Simulator With HDL Processor Model, Hard Prototyping: Classification Of Hard Prototyping, Requirements Of Hard Prototyping, Examples Of Conventional Hard Prototyping System, Issues On Hardware/Software Co-Emulation **Soc Testing And Design For Testability:** Test Access Control System (TACS), A Typical Soc Test Design Flow, A Tacs-Based Soc Architecture, Test Integration Issues And Solutions, STEAC: Soc Test Aid Console, BRAINS	8

6.	**Digital Circuit Design using Verilog:** **Gate Level Modeling:** Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples, Tristate Gates, Array of Instances of Primitives, Design of Flip-Flops with Gate Primitives **Modeling at Dataflow Level:** Introduction, Continuous Assignment Structure, Delays and Continuous Assignments, Assignment to Vector, Operators. **Switch Level Modeling:** Basic Transistor Switches, CMOS Switches, Bidirectional Gates, Time Delays with Switch Primitives, instantiation with strengths and delays, Switch level modeling for NAND, NOR and XOR.	**8**
	Total	**45**

Text Books:

1. Patrick R. Schaumont, "A Practical Introduction to Hardware/Software Co-design",SpringerPublications.
2. Vijay Madisetti, Chonlameth Arpnikanondt, A Platform-Centric Approach to System-on-Chip (SOC) Design (2004)
3. Youn-Long Steve Lin, Essential Issues in Soc Design - Designing Complex Systems-On-Chip (2010)
4. T.R. Padmanabhan, B Bala Tripura Sundari, Design Through Verilog HDL, Wiley 2009.

Reference Books:

1. Weng Fook Lee - Verilog Coding for Logic Synthesis (2003, Wiley-Interscience)
2. VaibbhavTaraate, Advanced HDL Synthesis and SOC Prototyping - RTL Design Using Verilog (2019)
3. KatalinPopovici, Frédéric Rousseau, et al., Embedded Software Design and Programming of Multiprocessor System-on-Chip - Simulink and System C Case Studies (2010)
4. JariNurmi, Processor Design - System-on-Chip Computing for ASICs and FPGAs (2007)

Program: M.Tech (E&TC)-VLSI and Embedded Systems				Semester : I		
Course : Embedded Processor Architecture and Design				Code : MET1502B		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior Knowledge of
Basics of Embedded Systems, VHDL programming is essential

Objectives:
1. To explain architecture fundamentals of processor design
2. To explain memory management of CISC and RISC processors
3. To deliver knowledge of architecture and design issues in DSP
4. To update the information with respect to run time re-configurable processors

Outcomes:
After learning the course the students should be able to:
1. Apply knowledge about basic components of embedded processor architecture.
2. Visualize probable Problems, fallacies and Pitfalls in Processor Design
3. Understand Extreme CISC and RISC, Very Long Instruction Word (VLIW), overly aggressive pipelining, unbalanced processor.
4. Analyse the difference between DSP and Customizable processor architecture.
5. Design and implement Processor functional components like MAC, ALU using reconfigurable concept.
6. Select appropriate Clock distribution and power distribution in SoC design.

Detailed Syllabus:

Unit	Description	Duration (Hrs)
1.	**Embedded Computer Architecture Fundamentals I:** Components of an embedded computer, Architecture organization, ways of parallelism, I/O operations and peripherals. Problems, Fallacies, and Pitfalls in Processor Design for a high level computer instruction set architecture to support a specific language or language domain.	6
2.	**Embedded Computer Architecture Fundamentals II:** Use of intermediate ISAs to allow a simple machine to emulate it's betters, stack machines, overly aggressive pipelining, unbalanced processor design, Omitting pipeline interlocks, Non-power-of-2 data-word widths for general-purpose computing.	8
3.	**Processor Design Flow and Memory :** Capturing requirements, Instruction coding, Exploration of architecture organizations, hardware and software development. Extreme CISC and extreme RISC, Very long instruction word (VLIW). Memory: Organization, Memory segmentation, Multithreading, Symmetric multiprocessing.	8
4.	**Digital Signal Processor:** Digital signal processor and its design issues, evolving architecture of DSP, next generation DSP. **Customizable processors:** Customizable processors and processor customization, A benefit analysis of processor customization, use of microprocessor cores in SOC design, benefits of microprocessor extensibility.	9
5.	**Run time Re-configurable Processors:** Run time Re-configurable Processors, Embedded micro-processor trends, instruction set metamorphosis, reconfigurable computing, run-time reconfigurable instruction set processors, coarse grain reconfigurable processors. Processor.	6

6.	**Clock Generation and Distribution:** Clock parameters and trends, Clock distribution networks, de-skew circuits, jitter reduction techniques, low power clock distribution. **Asynchronous Processor Design:** Asynchronous and self-timed processor design, need of asynchronous design, development of asynchronous processors, asynchronous design styles, features of asynchronous design.	**8**
	Total	**45**

Text Books:

1. NurmiJari,“ Processor Design-System on Chip Computing for ASICs and FPGA”, Springer Publications.
2. Frantz G, “The DSP and Its Impact on the Technology”.

Reference Books:

5. Leibson S, Tensilica, “Customizable Processors and Processor Customization”.
6. Campi F, “Run-Time Reconfigurable Processors”.
7. Garside J, Furber S, “Asynchronous and Self-Timed Processor Design”.
8. Rusu S, “Processor Clock Generation and Distribution”.
9. Dehon Andre, “Reconfigurable Architecture for General purpose Computing”.

Program: M.Tech (E&TC)-VLSI and Embedded Systems					**Semester:** I	
Course: System Design with Embedded Linux					**Code:** MET1502C	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior Knowledge of
System Programming and Operating Systems, Embedded Systems**Is Essential.**

Objectives: Faculty need

1. To explain fundamentals of embedded Linux.
2. To explain how to use GNU tool chain.
3. To explain how to implement embedded Linux applications.

Outcomes:
After learning the course, the students should be able to:

1. Demonstrate the embedded Linux system.
2. Develop the code for drivers in embedded Linux.
3. Develop the setup for Host-target system.
4. Apply the Linux kernel porting.
5. Develop the applications in embedded Linux.

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs)**
1.	**Introduction to Real Time Operating Systems:** Design goals for Real-time software, Tasks Specifications and types, Real-Time Scheduling Algorithms, Concurrency, Inter- process communication and Synchronization mechanisms, Priority Inversion, Inheritance and Ceiling	**8**
2.	**Introduction to Embedded Linux:** Embedded Linux, Types of Embedded Linux systems, Advantages of Linux OS, Embedded Linux Distributions, Examples of Embedded Linux systems- system architecture	**8**
3.	**Host-target development setup:** Development languages and tools, Hardware support, Debug setups, Boot Configurations, Processor architectures supported by Linux	**7**
4.	**Cross Development and Configuration:** Cross tool chains, Kernel Architecture – HAL, Memory manager, Scheduler, File System, I/O and Networking subsystem, IPC, User space, Start-up sequence, Kernel initialization, System initialization, Bootloaders	**6**
5.	**Device Driver Development:** Device driver basics, Communication between user space and kernel space drivers, Character and Block Device Drivers, Interrupt handling, Kernel modules and utilities, File systems, MTD sub systems, Busybox	**8**

6.	**Porting Linux and Device applications:** Popular target configurations, Linux porting, GNU debugger, Tracing & profiling tools, Debugging embedded linux applications, Device Applications, Asynchronous serial communication interface, Parallel port interfacing, USB interfacing, Memory I/Ointerfacing	**8**
	Total	**45**

Text Books:

1. Edward A. Lee and Sanjit A. Seshia, "Introduction to Embedded Systems" , A Cyber-Physical Systems Approach, Second Edition, MIT Press, ISBN 978-0-262-53381-2, 2017.
2. Bruce Powel Douglass , Design Patterns for Embedded Systems in C, Newnes Publisher , ISBN: 9780080959719, 2010
3. Robert Oshana, Mark Kraeling, "Software Engineering for Embedded Systems: Methods, Practical Techniques", Elsevier, 1st Edition, 2013.
4. Qing Li, Caroline Yao,Real-Time Concepts for Embedded Systems, R and D Developer Series CMP books, CRC press.
5. Doug Abbott ,Linux for Embedded and Real-time Applications, Newnes Publisher, Elsevier, 2003.

Reference Books:

1. Karim Yaghmour, Jon Masters, Gillad Ben Yossef, Philippe Gerum, "Building embedded linux systems", 2nd edition, Wiley publisher, 2008.
2. Christopher Hallinan, "Embedded Linux Primer: A practical real world approach", 2nd edition, Prentice Hall, 2007.
3. Craig Hollabaugh, "Embedded Linux: Hardware, software and Interfacing", 2nd edition, Pearson Education,2002.
4. Doug Abbott, "Linux for embedded and real time applications", 4th edition, Science direct, 2003.

Program: M. Tech (E&TC)-VLSI and Embedded Systems				Semester: I		
Course: Embedded System Applications				Code: MET1502D		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior Knowledge of
automotive electronics, embedded systems, control systems, communication engineering, **Is Essential.**

Objectives:

1. To understand, design and model various automotive control systems using Model based development technique.
2. To describe various communication systems, wired and wireless protocols used in vehicle networking.
3. To conceptualize automotive electronic technologies for future
4. To deliver knowledge of Signal Processing and Time-frequency transforms required for biomedical processing and data mining.
5. To give the students an understanding of Bioelectric signals, electrodes and its dynamics
6. To introduce biomedical pre-processing methodologies, instrumentation and its applications.

Outcomes:
After learning the course, the students should be able to:

1. Understanding fundamentals of ADAS and architectural overview of automotive control systems.
2. Acquire knowledge about Automotive Standards and Protocols and Sensor Technology to ADAS
3. Acquire knowledge of Intelligent transport system and AUTOSAR.
4. Understand concept of bio-electric signals such as EEG, ECG and EMG and its relevance for normal and abnormal state
5. Design real time pre-processing system required for medical signal processing and medical imaging.
6. Design automated, handheld embedded systems used in society for addressing health and hygiene challenges

Detailed Syllabus:

Unit	Description	Duration H
1.	**Automotive Embedded systems , Standards and Protocols:** Introduction to functional building blocks of embedded systems, Criteria to choose the right microcontroller/processor for various automotive applications, The need for Protocol, LIN, CAN, KWP2000 & J1939, FlexRay, Test calibration and diagnostics tools for networking of electronic systems like ECU, Vehicle network simulation	**8**
2.	**Sensor Technology for Advanced Driver Assistance Systems**: Basics of Advanced driver assistance systems, Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems	**8**
3.	**Intelligent Transportation Systems and AUTOSAR:** Vehicle-to-X (V2X) Communication for Intelligent Transportation Systems (ITS), Safety and non-safety applications, Use cases, **AUTOSAR :** Constituent elements of AUTOSAR, AUTOSAR methodology and implementations Case study : e vehicles	**8**
4.	**Introduction:** Origins of Bioelectric signals, Electrocardiogram (ECG), Electromyogram (EMG); Recording Electrodes- Silver-silver Electrodes, Electrodes for ECG, EEG and EMG; electrodes types and selection of Sensors and **Recording Electrodes:** Electrode-tissue interface, polarization, skin contact impedance, effects of artifacts, Silver-Silver Chloride electrodes, Electrodes for EEMG, EEG, single channel and multi-channel EEG. Electrical Conductivity of Jellies and Creams, Microelectrodes	**8**

5.	**Signal processing for ECG**: ECG signal origin, ECG parameters-QRS detection different techniques, ST segment analysis. Signal averaging: Basics of signal averaging, Signal averaging as a digital filter, A typical averager, Software and limitations of signal averaging. Adaptive Filtering: Introduction, General structure of adaptive filters, LMS adaptive filter, adaptive noise cancellation, Spectral Estimation: Introduction and methods	**6**
6.	**Medical Imaging:** Magnetic Resonance Imaging: Introduction, principles of MRI and fMRI, MRI instrumentation, image acquisition and reconstruction techniques, Application of MRI. **Data Acquisition and Case studies:** Introduction, Measurement and Automation Explorer, DAQ Assistants, Analysis Assistants. Biomedical toolkit- ECG signal acquisition & feature extraction, Patient Monitoring Systems, Intelligent Health care system, Telemedicine	**7**
		45

Text Books:

1. William B. Ribbens, "Understanding Automotive Electronics- An Engineering Perspective", Seventh edition, Butterworth-Heinemann Publications.
2. Nicolas Navet "Automotive Embedded Systems Handbook", by, CRC press
3. J.C. Proakis& M.G. Manslakis Digital Signal Processing: Principles, Algorithms & Application, , PHI
4. Arnon Cohen, Biomedical Signal Processing Time and Frequency Domains Analysis (Volume I), , Edition, 1986, CRC press, ISBN: 978-1-111-42737-5.
5. D.C.Reddy , Biomedical Signal Processing Principles and Techniques, Tata McGraw-Hill, ISBN: 978-1-111-42737-5, 2012.

Reference Books:

1. Frank Vahid and Tony Givargis "Embedded System Design: A unified Hardware / Software Introduction" –, Wiley India Publishers.
2. Patrick R. Schaumont "A Practical Introduction to Hardware/Software Co-Design"-, Springer Publishers.
3. G. Meyer, J. Valldorf and W. Gessner: "Advanced Microsystems for Automotive Applications", Springer.
4. AUTOSAR Documentation [on line]. Available on: www.autosar.org
5. R. S. Khandpur , Handbook of Biomedical Instrumentation, 3 rd Edition, 2011, Tata Mc Graw-Hill , ISBN: 9780070473553.
6. Willis J. Tompkins, Biomedical Digital Signal Processing, , edition, 2000, PHI, ISBN: 978-1-111- 42737-5
7. E.S. Gopi, Digital Signal Processing for Medical Imaging Using Matlab, Springer, 2013.

Program:	M.Tech (E&TC)-VLSI and Embedded Systems				Semester :	I
Course :	Professional Elective Lab-I				Code :	MET 1503
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	50

Prior Knowledge of

1. Basics of VLSI Design Flow, Basics of FPGA, Basics of Embedded Systems and Computer Network
2. Basics of VHDL, Embedded C, Python and MATLAB**Is Essential.**

Objectives:

1. To provide students implementation approaches of FPGA design
2. To develop comprehensive approach towards building small low cost embedded IoT system.
3. To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.
4. To explore processor design concept and principles.
5. To enhance programming skills of students in the field of VLSI and Embedded Systems

Outcomes: On completion of the course, student will be able to:

1. Understand significance of hardware and software co-design principle.
2. Implement an architectural design for IoT for specified requirement.
3. Understand the role of computer-aided design (CAD) tools in automating the design flow and providing improved productivity in VLSI systems design.
4. Develop, simulate and integrate control algorithms for integration of processor design.
5. Program various applications using Front End and Backend Tools, MATLAB, Python and C.
6. Compare and select Linux and embedded Linux utilities with respect to real time applications.

Guidelines :

1. Total 6 experiments to be conducted along with one experiment of for Hardware and Software training and Introduction from Part A and Part B.
2. Total 8 experiments of 30 hours.

Detailed Syllabus:

Part A: Elective 1- Advanced Signal Processing and Processor Design (ANY Three)

Expt.	Description
1.	To implement and verify linear and Circulation convolution using MATLAB
2.	Implementation of Decimation and Interpolation using MATLAB
3.	Implementation of Real-Time ECG QRS Detection using Simulink
4.	Implementation of Audio/Image /Video processing using Digital Signal Processor using DSP Processor

Part A: Elective 1- Microelectronic Devices and Modelling (ANY Three)

Expt.	Description
1.	Characterize n-MOSFET with the given model parameters, from the parameters students will reproduce I-V characteristics. Replace the model with any other SPICE model. Compare both the I-V characteristics.
2.	Characterize p-MOSFET with the given model parameters, from the parameters students will reproduce I-V characteristics. Replace the model with any other SPICE model. Compare both the device I-V characteristics.
3.	Characterize n-MOSFET and p-MOSFET to find out low frequency C-V characteristics behavior with the given model parameters.
4.	Characterize n-MOSFET and p-MOSFET to find out high frequency C-V characteristics behavior with the given model parameters.

Part A: Elective 1- CAD Algorithms for VLSI Design (ANY Three)	
Expt.	**Description**
1.	Design, synthesis, simulation and implementation of 4 bit ALU on Xilinx and download onto FPGA.
2.	Introduction to layout design rules Layout, physical verification, placement & route and static timing analysis for CMOS inverter
3.	Layout, physical verification, placement & route and static timing analysis for CMOS NOR and NAND gate
4.	Introduction to SPICE simulation and coding of NMOS/CMOS circuit
Part A: Elective 1- Embedded Networking (ANY Three)	
Expt.	**Description**
1.	Interfacing SD card to LPC2148 using SPI
2.	Interfacing EEPROM to LPC2148 using I2C protocol
3.	Interfacing GSM with LPC2148 for sending and receiving message and voice call
4.	Interfacing GPS with LPC2148 for finding current location latitude and longitude values
Part A: Elective 1- Advanced Devices and modeling for VLSI(Any Three)	
Expt.	**Description**
1.	Demonstration of Implementation of Fin Fet in Microwind
2.	Implementation of Basic gate using QCAD
3.	Case study on SET for Ultra low power Design.
4.	To design and plot the static (VTC) and dynamic characteristics of a digital CMOS inverter using Shakshat Virtual Lab INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
Part B: Elective 2- System on Chip(ANY Three)	
Expt.	**Description**
1.	Design, simulate and implement FSM on PLD for detection of either of input sequence X = 1001, What is effect on area, speed, fan out and power by implementing this design using different state encoding styles?
2.	Design and implement MOD4 counter on PLD and verify multi-clock operations
3.	Design and implement FSMD for Euclids GCD
4.	Implement temperature logging system as a co-design by Interfacing FPGA &μC
Part B: Elective 2- Embedded Processor Architecture and Design (ANY Three)	
Expt.	**Description**
1.	Design and implement MAC Unit on PLD
2.	Design and implement CPU on PLD
3.	Design and implement Carry look-ahead generator on PLD
4.	Design and implement 4 bit processor for 4 arithmetic and 4 logical operations.
Part B: Elective 2- System Design with Embedded Linux (ANY Three)	
Expt.	**Description**
1.	Bootloader compilation and downloading on Target board.
2.	Download pre-compiled Linux kernel images on Target board. Configure and boot an embedded Linux relying on block storage
3.	Develop character device driver for GPIO.
4.	Write a program for External Interrupt Handling.
Part B: Elective 2- Embedded System Applications **(ANY Three)**	
Expt.	**Description**
1.	Introduction to Simulink and SimDriveline for modelling an automotive control system.
2.	Implement any one application prototype using Simulink from below: Adaptive cruise control, Engine Management System, Power windows and automotive lighting system, etc.

3.	Design and implement DWT for EEG / ECG Signal Processing using MATLAB / Python
4.	Design and implement real time invasive/ non-invasive glucose measurement system using PSoC or OMAP

Text Books:

1. G. D. Micheli, Synthesis and Optimization of Digital Circuits. McGraw Hill,1994.
2. Doug Abbott ,Linux for Embedded and Real-time Applications, , Newnes, Elsevier,2003.
3. Xilinx ISE Simulation Guide :https://www.xilinx.com/support/documentation/sw_manuals/xilinx14_7/sim.pdf
4. MATLAB user guide :https://in.mathworks.com/help/pdf_doc/matlab/index.html?s_tid=mwa_osa_a

Program:	M. Tech (E&TC)-VLSI and Embedded Systems			Semester :	I
Course :	LAB Name : Skill Development Lab-I			Code :	MET1405
Teaching Scheme			Evaluation Scheme		
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	--	50

Prior Knowledge of
Basics of C, MATLAB, Python, VHDL**Is Essential.**

Objectives:

1. To strengthen the software programming skills of thestudents.
2. To strengthen the hardware programming skills of thestudents.
3. To develop knowledge of hardware and software co-design and to implement it on VLSI and Embedded platform.

Outcomes:
After learning the course the students should be able to:

1. Understand all the programming in the field of VLSI and Embedded Systems.
2. Design real time application using software and hardware tools
3. Understand IC design and fabrication flow.

Guidelines :

1. Total experiments to be conducted are **any three from Experiment 1-4 and any three from experiment5-8.**

2. Total : 6 experiments 16hours (Experiment 2 and 5 are compulsory)

Detailed Syllabus:

Skill Development Lab

Expt.	Description
1.	Execute the Xilinx ISE tool design flow and verify for various modelling styles of VHDL with suitable examples on FPGA
2.	Execute Vivado tool design flow and implement 4 bit counter using FPGA
3.	Explore any two evaluation boards of FPGA / CPLD for interfacing with atleast two I/O modules such as Bluetooth , WAN, I2C, E2POM, ADC, DAC etc
4.	Execute Mentor graphics Tool HEP-I and HEP-II Design Flow with simple example.
5.	Explore MATLAB Tool for adding new Toolbox and available libraries and execute HDL coder flow and System Generator flow of MATLAB for VHDL conversion.
6.	Explore ARM9/ ARM cortex Board using Embedded Linux and interface simple I/Os
7.	Explore Python Design flow for implementing design on hardware boards such as Raspberry Pi or Arduino
8.	Explore Code Composer Studio and OMAP 138 board for simple application.

References:

1. Xilinx ISE Simulation Guide :https://www.xilinx.com/support/documentation/sw_manuals/xilinx14_7/sim.pdf
2. MATLAB user guide : https://in.mathworks.com/help/pdf_doc/matlab/index.html?s_tid=mwa_osa_a
3. Vivado User Guide:
https://www.xilinx.com/support/documentation/sw_manuals/xilinx2020_1/ug904-vivado-implementation.pdf
4. System Generator User Manual
:https://www.xilinx.com/support/documentation/sw_manuals/xilinx11/sysgen_user.pdf
5. OMAP User Guide
:https://www.ti.com/lit/ug/spruh77c/spruh77c.pdf
6. User Manual Code ComposerStudio:
https://software-dl.ti.com/ccs/esd/documents/users_guide/index.html

Course Syllabus

Semester-II

Program:	**M.Tech (VLSI& Embedded Systems)**				**Semester:**	**II**
Course:	**Advanced CMOS Design**				**Code:**	**MET2406**
TeachingScheme				**Evaluation Scheme**		
Lecture	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior knowledge of
Basic fundamentals of electronic devices and integrated circuits
is essential.

Objectives:

1. Explain theconcepts of analog circuits design using MOS small signal models
2. Demonstrate design principles and techniques of CMOS sub-circuits and CMOS Amplifiers
3. Describe the concept of stability and explain methods of frequency compensation.

Outcomes:
After learning the course, the students should be able to:

1. Describe the small signal models MOS technologies
2. Design current sources and voltage references
3. Design single-ended differential amplifiers
4. Analyze and design operational amplifiers
5. Explain different techniques of frequency compensation
6. Describe the basis operation and analysis of Switched capacitor circuits

DetailedSyllabus:

Unit	**Description**	**Duration h**
1.	**MOS DEVICES AND MODELING:** Introduction to analog design, Analog integrated circuit design considerations, The MOS Transistor, Passive Components- Capacitor & Resistor MOSFET Modeling: MOS transistor Low frequency MOSFET Models, High frequency MOSFET Models, temperature effects in MOSFET, Noise in MOSFET	8
2.	**CMOS Sub circuits:** MOS as a switch, MOS Diode/Active resistor, Current Source, Sinks, Simple current sinks and mirror, Basic current mirrors, advance current mirror, Current and Voltage references, Bandgap references	6
3.	**Single stage amplifiers:** Common-Source stage (with resistive load, diode connected load, current-source load, triodeload, source degeneration), source follower, common-gate stage, Cascode stage, Folded Cascodestage. Frequency responses of CS stage, CD stage, CG stage, Cascode stage, simulation ofCMOS amplifiers using SPICE.Performance's matrices of amplifier circuits	8
4.	**CMOS Differential Amplifier:Single ended and Differential Operation, Qualitative and QuantitativeAnalysis of Differential pair, Common Mode response, Gilbert Cell.** Differential signaling: Differential to single ended conversion, source coupled pair, Current source load, CMOS Differential amplifier with current mirror load, small signal analysis of differential amplifier, Performance parameters,	8
5.	**CMOS Operational Amplifier:** Block diagram of Op-amplifier, Ideal characteristics of Op-Amplifier, Design procedure of two stage Op Amplifier, Compensation of Op-Amplifier, Frequency response of Op-Amplifier, Gain Boosting, Comparison of various topologies, slew rate, Offset effects, PSRR	7
6.	**Advanced Operational Amplifier:** Cascode and folded Cascode op-amps, common mode feedback techniques, high gain opamp architectures, **Switched Capacitor Circuits:** Basic operation and analysis of Switched Capacitor Circuits, Switched Capacitor Filters.	8
	Total	**45**

Text Books:

3. BehzadRazavi, Design of Analog CMOS Integrated Circuits, Boston: McGraw Hill, 2001.
4. D.A. Johns and K. Martin, Analog Integrated Circuit Design, New York: Wiley, 1997. P.E.

ReferenceBooks:

3. Allen and D.R. Holberg, CMOS Analog Circuit Design, 2nd Ed., Oxford University Press, 2002.
4. P.R. Gray, P.J. Hurst, S.H. Lewis, and R.G. Meyer, Analysis and Design of Analog Integrated Circuits, 4th ed., New York: Wiley, 2001.

Program:	**M. Tech. (E&TC)-VLSI and Embedded Systems**				**Semester :**	
Course :	**Embedded System Programming**				**Code :**	**MET2407**
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior Knowledge of

Embedded System Design**Is Essential**

Objectives:

1. To explain the need of programming to design an application specific systems.
2. To explicate concepts of hardware for embedded application.
3. To introduce role of RTOS in design and implementation of real time system.
4. To provide insights of open source platform for embedded system

Outcomes:

After learning the course the students should be able to:

1. Understand need and working of real-time operating system in embedded System
2. Analyze the hardware – software co design issues and testing methodology for embedded system.
3. Apply knowledge of defining process and task in multi-tasking applications,
4. Develop real-time algorithm for task scheduling and inter-process communication using uCOS-II.
5. Analyze the features and principle of Embedded Linux over Linux OS.
6. Design Android based small application modules.

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs)**
1.	**Real time system and RTOS** Real time system, types, design approaches and considerations, Usage of Shared resources and related issues, Concept of RTOS, Types of RTOS, differences from GPOS (Multitasking, Inter-process communication, Timers, Device drivers, protection mechanism etc.), real time scheduling algorithms, commercial RTOS.	**7**
2.	**Concepts of RTOS:** Tasks and Task states, Task Creation, Intertask Communication: Semaphores, Shared data, Message queues, Mail boxes and Pipes, Memory management, Interrupt routines, Hard Real-time scheduling, Power saving, Device Driver Studies, Driver Module explanation.	**8**
3.	**µcos-II –RTOS:** µcos-II features, kernel structure, data structure, µcos-II services as task management, time management, inter-process communication (mailbox, queue, events, pipes, etc.),memory management. µcos-II porting on ARM7/Cortex (M3/M4) architecture.	**8**

4.	**Embedded Linux:** Linux for embedded systems, embedded Linux development system, kernel architecture and configuration, file systems, porting Linux on ARM architecture, boot loaders, tool utilities such as Minicomp, Busybox, Redboot, Libc, Device drivers-concept, architecture, types, sample character device driver.	**8**
5.	**Android Operating System:** Introduction to Android technology, Structure of Android applications, Understanding Manifest, Working with Activities, Data stores, Network services and APIs, Intents, Content Providers and services, Advance Operations with Android, Case Studies: Telephony and SMS, Audio-Video using the Camera. Recent Trends in RTOS:	**8**
6.	Case studies- RTOS for Image Processing – Embedded RTOS for Network Communication, RTOS for fault-Tolerant Applications, RTOS for Control Systems.	**6**
	Total	**45**

Text Books:

1. Rajkamal, Embedded Systems: Architecture, Programming and Design, Tata McGraw-Hill Education, 2008
2. Labrossy J. J, Lawrence, "µC/OS-II, The real time Kernel", R & D Publication. (added)
3. Hallinan Christopher, "Embedded Linux Primer: A Practical Real-World Approach", Second Edition, Pearson Education, 2006.

Reference Books:

1. Frank Vahid and Tony Givargis, "Embedded system design: a unified hardware/software Introduction",Wiley , 2002.
2. Tanenbaum A S, "Modern Operating Systems", 4e, Prentice Hall, 2015.
3. Chris Simmonds, "Master the techniques needed to build great, efficient embedded devices on Linux",
4. Dr Prasad K V K K, "Embedded Real Time Systems: Concepts, Design & Programming", Dreamtech Publication, 2003.
5. Android Karim Yaghmour - Embedded Android_ Porting, Extending, and Customizing (Early Release) -O'Reilly, 2011
6. VxWorks Programmers Guide

Program:	M.Tech (E&TC)-VLSI and Embedded Systems				Semester :	II
Course :	Professional Core Lab-II				Code :	MET 2408
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	50

Pre-requisite:

Front End Tools and Back End Tools, C Language basics and Interfacing basics and Operating Systems basics is Essential

Objectives:

1. To design and analyze CMOS circuits
2. To measure performance analysis of analog circuits
3. To understand the significance of RTOS in embedded systems
4. To study interfacing of peripherals using u Cos-II

Outcomes:

After learning the course the students should be able to:

1. Handle design flow of Mentor Graphics and Xilinx for circuit design
2. Able to do the Synthesis and Post synthesis of the circuits
3. Interface the advanced peripherals to ARM based microcontroller using RTOS
4. Carry out programming using multitasking and inter process communication protocols

Guidelines :

1. Total experiments to be conducted are 8 **experiments of 30 hours**

Detailed Syllabus:

Part A: Advanced CMOS Design

Expt.	Description
1.	Design and prepare layout of MOS current sources and current mirrors.
2.	Design and simulation of common source amplifier.
3.	To design, prepare layout and simulate CMOS differential amplifier for DC gain of 40 dB.
4.	Comment on UGB, phase margin, CMRR

Part B: Embedded System Programming and Real time OS

Expt.	Description
1.	Porting of ucos-II on ARM7 controller. Implementation/Verification of multitasking (minimum 03 tasks) with ucos-II on ARM7 controller.
2.	Implementation of semaphore with ucos –II service ARM7 controller for resource management and synchronization.
3.	Programming on motor control with exploring on-chip PWM of Cortex based microcontroller.
4.	Exercise on Porting of Linux on ARM9 board Writing simple application using embedded Linux on ARM9

Reference Books:

1. Allen and D.R. Holberg, CMOS Analog Circuit Design, 2nd Ed., Oxford University Press, 2002.
2. P.R. Gray, P.J. Hurst, S.H. Lewis, and R.G. Meyer, Analysis and Design of Analog Integrated Circuits, 4th ed., New York: Wiley, 2001.
3. Dr Prasad K V K K, “Embedded Real Time Systems: Concepts, Design & Programming”, Dreamtech Publication, 2003.

Program: M.Tech (E&TC)-VLSI and Embedded Systems					**Semester : II**	
Course : Reconfigurable Computing					**Code : MET2504A**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior Knowledge of
Basics of VLSI design Flow, Basics of FPGA**Is Essential.**

Objectives:

1. To understand various computing architectures
2. To provide students the concept of handling issues of reconfigure computing
3. To provide students implementation approaches of FPGA design in view of reconfiguration
4. To outline various applications reconfigure computing

Outcomes:
After learning the course the students should be able to:

1. Understand the concept of reconfigurable computing and its integration on computing platforms
2. Analyze the existing Reconfigurable Processing Fabric (RPF) Architectures
3. Design, implement and analyze reconfigurable systems in the recent application domains using HDL
4. Use advanced EDA tools to simulate and synthesize HDL codes for reconfigurable architectures.
5. Compare reconfigurable platforms and SoPC platforms

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs)**
1.	General overview of computing models, Basic RC concepts, Domains of RC: General Purpose Computing, Domain-Specific Processors, Application-Specific Processors, Reconfigurable Computing, Fields of Application.	**8**
2.	Architecture of Field Programmable Gate Arrays, Reconfigurable Processing Fabric (RPF) Architectures: Fine grained, Coarse-Grained	**8**
3.	Integration of RPF into Traditional Computing Systems, Early systems of Reconfigurable computing: PAM, VCC, Splash, PRISM, Teramac, Cray, SRC	**8**
4.	Reconfiguration Management: Reconfiguration, Configuration architectures, managing reconfiguration process, reducing reconfiguration time, configuration security	**7**
5.	FPGA Design Flow, System On A Programmable Chip: Introduction to SoPC, Adaptive Multiprocessing on Chip.	**8**
6.	RC Applications: Implementing applications with FPGAs, various applications and use of reconfiguration: case study: Distributed arithmetic, Software Defined Radio, High-Performance Computing	**6**
	Total	**45**

Text Books:

1. Scott Hauck and Andre DeHon, Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation, Morgan Kaufmann (Elsevier),2008.
2. Bobda C. Introduction to reconfigurable computing: architectures, algorithms, and applications. Springer Science & Business Media;2007.

Reference Books:

1. M. Gokhale and P. Graham, Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays, Springer,2005.
2. Cardoso, Joao, and Michael Hübner, eds. Reconfigurable computing: from FPGAs to hardware/software codesign. Springer Science & Business Media,2011.
3. Hsiung, Pao-Ann, Marco D. Santambrogio, and Chun-Hsian Huang. Reconfigurable System Design and Verification. CRC Press,2018.
4. Gokhale, Maya B., and Paul S. Graham. Reconfigurable computing: Accelerating computation with field-programmable gate arrays. Springer Science & Business Media,2006.

Program: M.Tech (E&TC)-VLSI and Embedded Systems				**Semester :** II		
Course: IOT in Embedded System				**Code :** MET2504B		
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior Knowledge of Knowledge of Embedded system, Basics of Computer Network **Is Essential.**

Objectives:

1. To explain fundamentals of IoT and embedded system including essence, basic design strategy and process modeling.
2. To introduce students a set of advanced topics in embedded IoT and lead them to understand research in network.
3. To develop comprehensive approach towards building small low cost embedded IoT system.
4. To give details fundamentals of security for IoT and real world application scenarios of IoT along with its societal and economic impact using case studies

Outcomes:

After learning the course the students should be able to:

1. Describe basic components of IoT and identify different components of IoT based design
2. Understand the different IoT protocols and the cloud storage models
3. Implement an architectural design for IoT for specified requirement
4. Solve the given societal challenge usingIoT
5. Choose between available technologies and devices for stated IoTchallenge
6. To understand fundamentals of security inIoT,

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs)**
1.	Introduction to Embedded System and Internet of Things o Embedded Systems, IoT: Definition and characteristics of IoT, Internet of Things: Vision, Emerging Trends, Economic Significance, Technical Building Blocks, Physical design of IoT, Things of IoT, IoT Protocols, IoT Issues and Challenges, Applications	8
2.	Embedded IoT Platform Design Methodology Purpose and requirement specification, Process specification, Domain model specification, information model specification, Service specifications, IoT level specification, Functional view specification, Operational view specification, Device and component integration, Application development	8
3.	IoT Protocols Device Connectivity- BLE Mesh & Bluetooth, ZigBee &ZWave, ModBus& CAN Bus, DALI & DMX, LAN & WAN Connectivity- Wi-Fi & Ethernet, LoRa& 6LowPan, BACnet	7
4.	IoT Security: Vulnerabilities of IoT, Security Requirements, Challenges for Secure IoT, Threat Modeling, Key elements of IoT Security: Identity establishment, Access control, Data and message security, Non-repudiation and availability, Security model for IoT	6
5.	IoT Physical Servers, and • Introduction to Cloud Storage Models, Communication API, • WAMP: Autobahn for IoT,. Cloud Connectivity- REST API, MQTT, JSON, COAP, DLMS, IPv4, IPv6	8
6.	Cloud Offerings - Xively Cloud for IoT, Python Web Application Framework: Django, Amazon Web Services for IoT, Skynet IoT Messaging Platform. Case Studies: Home Intrusion Detection, Weather Monitoring System, Air Pollution Monitoring, Smart IrrigationDeveloping	**8**

	Total	45

Text Books:

1. ArshdeepBahga and Vijay Madisetti, Internet of Things: A Hands-on Approach, Universities Press, 2017.
2. Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases,CRC Press, 2017.

Reference Books:

1. WaltenegusDargie,ChristianPoellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"
2. Daniel Minoli, ―Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications‖, ISBN: 978-1-118-47347-4, Wiley Publications
3. Olivier Hersent, David Boswarthick, and Omar Elloumi, ―The Internet of Things: Key Applications and Protocols‖, Wiley Publications
4. HakimaChaouchi, ― The Internet of Things Connecting Objects to the Web‖ ISBN : 978- 1-84821-140-7, Wiley Publications

Program: M.Tech (E&TC)-VLSI and Embedded Systems					**Semester : II**	
Course : ASIC Design					**Code : MET2504C**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior Knowledge of Basics of PLDs**Is Essential.**

Objectives:

1. To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.
2. To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.
3. To give the student an understanding of basics of System on Chip and Platform based design

Outcomes:

After learning the course, the students should be able to:

1. Understand the design flow of different types of ASIC.
2. Familiarize with different types of methodologies, language, and Tools in ASIC
3. Gain knowledge about partitioning, floor planning, placement and routing including circuit extraction of ASIC
4. Analyse the trade-offs in ASIC design
5. Acquire knowledge about testability in ASIC
6. Understand recent trends in ASIC design

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs)**
1.	**INTRODUCTION TO ASICS**: IC Design Technologies, VLSI Design flow, Programmable ASICs - Antifuse, SRAM, EPROM, EEPROM based ASICs. Programmable ASIC logic cells, I/O cells and programmable interconnects.	**7**
2.	**ASIC Design flow:** Introduction to PLDS, ASIC and FPGA Design flows, Top-Down and Bottom-Up design methodologies, Gate arrays, Standard cells, FPGA and their synthesis.	**6**
3.	**ASIC Physical Design:** System partition -partitioning – partitioning methods – floor planning – placement – Routing: global routing – detailed routing – special routing – circuit extraction – DRC	**8**
4.	**Trade off in ASIC Design:** Introduction to Trade off issues at System Level,Optimization with regard to speed, area and power, asynchronous and low power system design. ASIC physical design issues, SI issues. Parameter extraction with Post layout simulation and Pre layout simulation.	**8**
5.	**Static Timing Analysis:** Basics of timing, Basics of STA, Timing paths, Skew, Slack, Timing issues, Maximum Frequency Calculation, Clock domain crossing	**8**
6.	**Resent trends in ASIC design** ASIC Verification and its issues, Types and features of existing available EDA tools. High performance algorithms for ASICS/ SoCs as case studies	**8**
	Total	**45**

Text Books:

1. M.J.S. Smith,“Application Specific Integrated Circuits”, Pearson, 2003
2. Weste, Neil HE, and Kamran Eshraghian. "Principles of CMOS VLSI design: a systems perspective.", Wesley Pub.Co.1985

Reference Books:

1. Douglas A. Pucknell& Kamran Eshraghian, Basic VLSI Design :Systems and Circuits, Prentice Hall of India Private Ltd. , New Delhi , 1989.
2. Mead C, Conway L. Introduction to VLSI systems. Reading, MA: Addison-Wesley; 1980.
3. Mukherjee A. Introduction to n MOS & VLSI systems design. Prentice-Hall, Inc.; 1986.
4. L. A. Glassey & D. W. Dobbepahl, The Design & Analysis of VLSI Circuits, Addison Wesley Pub Co. 1985.
5. Rabaey JM, Chandrakasan AP, Nikolić B. Digital integrated circuits: a design perspective. Upper Saddle River, NJ: Pearson Education; 2003.

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester :**	**II**
Course :	Hardware software Co-design				**Code :**	**MET2504D**
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior Knowledge of

1. SoC Modelling and Design
2. Programming language 'Verilog'**is essential.**

Objectives:

1. To explain the challenges and need of Hardware / Software Co-design
2. To demonstrate use of Verilog for FPGA Prototyping and processor design.
3. To explore the HW/SW Co-verification Environment.

Outcomes:

After learning the course the students should be able to:

1. Understand concept of Hardware / Software Co-design and its need in processor design
2. Analyze customizable architectures and their characteristics
3. Design Verilog, RTL based combinational and sequential circuits through FPGA Prototyping
4. Compare HW/SW Co-verification Environment required to design SoC / SoPC systems.
5. Design processor architecture considering requirements of applications.
6. Analyze and compare recent trends in multiprocessor/ multicore system.

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs)**
1.	**Essential Issues in Co-design:** Hardware/Software co-design flow, Models, Architectures, A Generic Co-Design Methodology, Hardware/Software Co-Synthesis Algorithms, Hardware/Software Partitioning, Distributed System Co-Synthesis	**6**
2.	**Customizable Architectures:** FPGA and CPLD architectures, Processor Customization, Run-Time Reconfigurable Processors, Buses and Protocols, High-Density FPGA Fabric and Buses, FPGA Design and Memories, SOC Prototyping Using FPGA, Testing at the Board Level.	**7**
3.	**FPGA Prototyping By VERILOG:** Gate-level combinational circuit, RT-level combinational circuit, Sequential Circuit, FSM and FSMD, IO Interfacing with UART, PicoBlaze Overview, PicoBlaze I/O and Interrupt Interface.	**8**
4.	**Hardware/Software Co-verification:**HW/SW Co-verification Environment, Soft or Virtual Prototypes, Emulation, Co-verification, Co-verification Methodology, UART Co-verification, Verilog Shell for UART Design, Rapid Prototype Systems, Reconfigurable RPS, Application-specific RPS, Comparing HW/SW Verification Methods, FPGA-based Design.	**8**
5.	**Processor Cores and Architecture Design**: Processor Architectures and Basic Parameters, Processor Architecture and Micro-architecture, Processor Micro-architecture, RTL Design and Synthesis Strategies using verilog, Use of Processors in SOC Prototyping.	**8**
6.	MPSoC Architecture and design: Hardware and Software Interaction, Basics of MPSoC Architecture, Physical Design of Multiprocessor Systems, Trends and Challenges for Multiprocessor Systems, An Introduction to Multi-Core System on Chip – Trends and Challenges, Reconfigurable Hardware in Multiprocessor Systems	**8**
	Total	**45**

Text Books:

1. Daniel D. Gajski, Jianwen Zhu, et al., Hardware - Software Co-Design - Principles and Practice (1997)

2. KatalinPopovici, Frédéric Rousseau, et al., Embedded Software Design and Programming of Multiprocessor System-on-Chip - Simulink and System C Case Studies (2010)
3. VaibbhavTaraate, Advanced HDL Synthesis and SOC Prototyping - RTL Design Using Verilog (2019)

Reference Books:

1. Douglas J. Smith, Hdl Chip Design - A Practical Guide for Designing, Synthesizing & Simulating Asics &Fpgas Using Vhdl or Verilog (1998)
2. Lionel Torres, Pascal Benoit, et al., Multiprocessor System-on-Chip - Hardware Design and Tool Integration (2011)
3. Pong P. Chu, FPGA Prototyping By Verilog Examples - Xilinx Spartan-3 Version (2008)
4. Prakash Rashinkar, Peter Paterson, et al., System-on-a-Chip Verification - Methodology and Techniques (2000)

Experiments: (Using Verilog)

1. Design and implement Instruction Set and ALU Design based architecture.
2. Design and implement architecture to load parallel data and to perform the right or left shift operation.
3. Design and implement serial-input serial-output register used to establish serial data communication.
4. Design and implement Adaptive UART.

Program: M. Tech (E&TC)-VLSI and Embedded Systems				Semester: II		
Course: Embedded System for Automotive Applications				Code: MET2505A		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior Knowledge of Knowledge of automotive electronics, embedded systems, control systems, communication engineering**,** Is Essential.

Objectives:

1. To describe various communication systems, wired and wireless protocols used in vehicle networking.
2. To conceptualize automotive electronic technologies for future

Outcomes:

After learning the course, the students should be able to:

1. To analyze various embedded products used in automotive industry.
2. To understand, design and model various automotive control systems using Model based development technique.
3. Develop, simulate and integrate control algorithms for ECUs with hardware
4. Understand the networking of various modules in automotive systems and communication protocols of interfacing different electronics components, systems and functional counterparts.
5. To interface devices and build a complete automotive control system.
6. Use AUTOSAR software and functional safety norms for automotive design

Detailed Syllabus:

Unit	Description	Duration (Hrs)
1.	**Automotive Embedded systems:** Introduction to functional building blocks of embedded systems, Criteria to choose the right microcontroller/processor for various automotive applications, Overview of automotive grade processors, understanding various architectural attributes relevant to automotive applications, Understanding and working on tool chains	**8**
2.	**Model Based Software Development:** Architectural overview of automotive control systems, Product lines in automotive electronics, MBD for Automotive Embedded Systems, Guidelines for Adopting MBD, Case study of modelling, simulation and implementation of Automotive systems (Cruise control of car, Artificial Intelligence based ADAS system, and Engine management system)	**8**
3.	**Automotive Standards and Protocols:** The need for Protocol, LIN, CAN, KWP2000 & J1939, FlexRay, Test calibration and diagnostics tools for networking of electronic systems like ECU, Vehicle network simulation	**8**
4.	**Sensor Technology for Advanced Driver Assistance Systems**: Basics of Advanced driver assistance systems, Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems	**8**
5.	**Intelligent Transportation Systems:** Vehicle-to-X (V2X) Communication for Intelligent Transportation Systems (ITS), Safety and non-safety applications, Use cases, Network service requirements of different applications, V2X communication regimes, Standards and Technologies	**6**

6.	**AUTOSAR and functional safety:** Constituent elements of AUTOSAR, AUTOSAR methodology, System-level architectures & examples, Functional safety, SW Architectural descriptions for functional safety, Hazard & Risk Analysis and determination of ASILs, Futuristic trends in automotive electronics	**7**
	Total	**45**

Text Books:

1. William B. Ribbens, "Understanding Automotive Electronics- An Engineering Perspective", Seventh edition, Butterworth-Heinemann Publications.
2. TaoZhang,LucaDelgrossi,"VehicleSafetyCommunications:Protocols,SecurityandPrivacy",Wiley Publication.
3. Nicolas Navet "Automotive Embedded Systems Handbook", by, CRC press

Reference Books:

1. Frank Vahid and Tony Givargis "Embedded System Design: A unified Hardware / Software Introduction" –, Wiley India Publishers.
2. Patrick R. Schaumont "A Practical Introduction to Hardware/Software Co-Design"-, Springer Publishers.
3. G. Meyer, J. Valldorf and W. Gessner: "Advanced Microsystems for Automotive Applications", Springer.
4. Allan Bonnick: "Automotive Computer Controlled Systems, Diagnostic Tools and Techniques", Elsevier Science.
5. AUTOSAR Documentation [on line]. Available on:www.autosar.org

Program:	**M. Tech (E&TC)-VLSI and Embedded Systems**			**Semester :**	**II**
Course :	Embedded Systems in Biomedical Applications			**Code :**	**MET2505B**
Teaching Scheme			**Evaluation Scheme**		
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior Knowledge of
Microcontroller, sensors and interfacing Programming understanding and Knowledge of Embedded C,MATLAB **Is Essential.**

Objectives:

1. To provide the knowledge of basic concepts such as measuring instruments and generalized instrumentation system, general properties of input transducers, static and dynamic characteristics of transducers and sensors.
2. To deliver knowledge of Signal Processing and Time-frequency transforms required for biomedical processing and data mining.
3. To give the students an understanding of Bioelectric signals, electrodes and its dynamics
4. To introduce biomedical pre-processing methodologies, instrumentation and its applications.

Outcomes:
After learning the course the students should be able to:

1. Understand sensors and electrodes for biomedical signal recording.
2. Understand concept of bio-electric signals such as EEG, ECG and EMG and its relevance for normal and abnormal state
3. Design real time pre-processing system required for medical signal processing and medical imaging.
4. Design hardware considering the trade-off between area, performance and power consumption, depending on the application.
5. Understand medical imaging concepts for disease analysis.
6. Design automated, handheld embedded systems used in society for addressing health and hygiene challenges.

Detailed Syllabus:

Unit	**Description**	**Duration h**
1.	**Introduction:** Origins of Bioelectric signals, Electrocardiogram (ECG), Electromyogram (EMG); Recording Electrodes- Silver-silver Electrodes, Electrodes for ECG, EEG and EMG; electrodes types and selection of Sensors. **Recording Electrodes:** Electrode-tissue interface, polarization, skin contact impedance, effects of artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, single channel and multi-channel EEG, Electrodes of EMG. Electrical Conductivity of Jellies and Creams, Microelectrodes.	**8**
2.	**Signal processing for ECG**: ECG signal origin, ECG parameters-QRS detection different techniques, ST segment analysis. Signal averaging: Basics of signal averaging, Signal averaging as a digital filter, A typical averager, Software and limitations of signal averaging. Adaptive Filtering: Introduction, General structure of adaptive filters, LMS adaptive filter, adaptive noise cancellation, Cancellation of 60 Hz interference in ECG, Cancellation of maternal ECG in fetal ECG.	**8**
3.	**Frequency Domain Analysis:** Introduction, Spectral analysis, linear filtering, cepstral analysis and homomorphic filtering. Removal of high frequency noise (power line interference), motion artifacts (low frequency) and power line interference in ECG / EEG. Time Series Analysis: Introduction, AR models, Estimation of AR parameters by method of least squares and Durbin's algorithm, ARMA models. Spectral modeling and analysis of PCG signals.	**6**

4.	Spectral Estimation: Introduction, Blackman-tukey method, The periodogram, Pisarenko's Harmonic decomposition, Prony' method, Evaluation of prosthetic heart valves using PSD Techniques, Comparison of the PSD estimation methods.	**8**
5.	**Medical Imaging:** Magnetic Resonance Imaging: Introduction, principles of MRI and fMRI, MRI instrumentation, image acquisition and reconstruction techniques, Application of MRI	**8**
6.	**Data Acquisition and Case studies:** Introduction, Measurement and Automation Explorer, DAQ Assistants, Analysis Assistants. Biomedical toolkit- ECG signal acquisition & feature extraction, EEG simulation, EMG power analysis. Image acquisition and processing, Patient Monitoring Systems, Intelligent Health care system, Telemedicine	**6**
	Total	**45**

Text Books:

1. J.C. Proakis & M.G. Manslakis Digital Signal Processing: Principles, Algorithms & Application, ,PHI
2. Arnon Cohen, Biomedical Signal Processing Time and Frequency Domains Analysis (Volume I), ,Edition, 1986, CRC press, ISBN:978-1-111-42737-5.
3. D.C.Reddy , Biomedical Signal Processing Principles and Techniques, Tata McGraw-Hill, ISBN: 978-1-111-42737-5,2012.

Reference Books:

1. R. S. Khandpur , Handbook of Biomedical Instrumentation, 3 rd Edition, 2011, Tata Mc Graw-Hill ,ISBN: 9780070473553.
2. Willis J. Tompkins, Biomedical Digital Signal Processing, , edition, 2000, PHI, ISBN: 978-1-111-42737-5
3. E.S. Gopi, Digital Signal Processing for Medical Imaging Using Matlab, Springer, 2013.

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester:**	**II**
Course:	**VLSI Testing and Design for Testability**				**Code:**	**MET2505C**
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior Knowledge of

1. Conceptual understanding of combinational and sequential digital circuits
2. Knowledge of frontend and backend design tools. Is Essential**.**

Objectives:

1. To introduce design process in VLSI
2. To understand the logical and Fault simulation models
3. To learn techniques for design of testability
4. To study hardware and software verification issues for testing

Outcomes:

After learning the course the students should be able to:

1. Understand fault models for generation of test vectors
2. Calculate observe ability and controllability parameters of circuit
3. Enhance testability of a circuit
4. Use simulation techniques for designing and testing of VLSI circuits
5. Plan verification test-cases and execute as applications.

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs)**
1.	**Introduction:** Introduction to VLSI (Very Large Scale Integration) design, verification and testing process, VLSI testing process and test equipment. Functional modelling at the logic and the register level, Structural models, Level of modelling. Type of simulation, unknown logic value different delay models, Hazard Detection.	8
2.	**Logical Fault Modelling and Simulation :**Logical fault models, Fault detection and Redundancy, Fault equivalence and fault location, Fault Dominance, Single stuck-fault models, Multiple stuck fault model, Testing for single stuck fault and Bridging fault, Fault sampling, Statistical fault analysis.	8
3.	**Testability:** Design for testability, Testability measure (SCOAP) Introduction to Built-in Self-test (BIST)., trade- offs, Ad hoc Design for Testability techniques, Test pattern generation for BIST, Scan and Boundary scan architectures, Self testing circuits for systems, memory & processor testing, PLA testing, automatic test pattern generation and TAP Controller, JTAG	8
4.	**Basics of Verification:** Design verification techniques based on simulation, analytical and formal approaches. Verification Planning Importance of Planning , Specifications, Identifying Corner Cases Targets and Metrics, Unit and System-Level Verification Planning	8
5.	**Verification Planning:** Prediction of Results, Advanced Checkers Reference, Models, Self-checking Test benches, Monitors, Scoreboards, Coherency,, Plan, Verification Environment, Debug, Regression, Escape Analysis, Re-use.	8
6.	**Verification Methodologies :**Functional verification: . OVM, UVM, VVM, Timing verification. Basics of equivalence checking and model checking. Hardware emulation System Verification	7
	Total	**45**

Text Books:

1. Bushnell M L, Agrawal V D, “Essentials of Electronic Testing for Digital, Memory and Mixed-SignalVLSI Circuits”, Kluwer AcademicPublishers.
2. Abramovici M, Breuer M A and Friedman A D, “Digital systems and Testable Design”, JaicoPublications.
3. Kropf T, “Introduction to Formal Hardware Verification,” SpringerPublications.

Reference Books:

1. Crouch A L, “Design Test for Digital IC’s and Embedded Core Systems”, PrenticeHall.
2. Rolf Drechsler, “Advanced Formal Verification” Kluwer Academic Publishers.

Program:	**M. Tech (E&TC)-VLSI and Embedded Systems**				**Semester:**	
Course:	**System Verilog for Verification**				**Code: MET2505D**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Prior Knowledge of

1. Fundamental knowledge of Digital System Design with Verilog HDL
2. Familiarity with C , C++ and Object Oriented Programming concept will be an added advantage **Is Essential .**

Objectives:

1. Make the students familiar with verificationprocess.
2. Study the different kinds of data types and basic concepts of OOP used in System Verilog.
3. Study of SystemVerilog Interfaces and Assertions techniques used in verification process.
4. Develop ability to measure functional coverage and universal verification environment.

Outcomes:

After learning the course the students should be able to:

1. Understand the basic principles of verification process and SystemVerilog.
2. Apply the concepts of classes and objects to write programs in SystemVerilog.
3. Demonstrate the concepts of Interfaces and Assertions.
4. Design and develop universal verification environment to verify and measure functional coverage of DUT.

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs)**
1.	**Verification Methodology Overview:**Introduction, Verification Process, Verification Plan, Verification Methodology Manual, Basic Testbench Functionality, Directed Testing, Methodology Basics, Constrained-Random Stimulus, Functional Coverage, Testbench Components.	8
2.	**Introduction to Verilog and System Verilog:** Overview and history of Verilog and system Verilog, A simple Verilog test bench, Identifier names, Logic values and literal values, Verilog and System Verilog data types, Procedural blocks, Tasks and functions, Procedural assignments (blocking and non-blocking), Programming statements and operators.	8
3.	**Basic Object Oriented Programming: S**ystem Verilog's class data type, Defining class objects, Class methods, Class inheritance, Extending class definitions (inheritance), Virtual methods, Virtual classes, Public and private classes, Creating a simple testbench in SystemVerilog.	7
4.	**SystemVerilog Interfaces and Assertions :** Using interfaces to simplify inter-module connections, Specifying interface views(modports),Using tasks and functions in interfaces,Using interfaces between the test bench and the DUT, Types of Assertions and examples.	8
5.	**Functional Coverage:** Coverage Types, Functional Coverage Strategies, Simple Functional Coverage Example, Coverage Options, Parameterized Cover Groups, Analyzing Coverage Data, Measuring Coverage Statistics During Simulation.	8
6.	**Overview of System Verilog UVM:** Importance of verification methodologies, UVM concepts, UVM verification components.	6
	Total	**45**

Text Books:

1. System Verilog for Verification: A Guide to Learning the Testbench Language Features, Chris Spear, Springer 2006
2. System Verilog for Design: A Guide to Using System Verilog for Hardware Design and Modeling, 2nd Edition, Stuart Sutherland, Simon Davidman and Peter Flake, Springer

Reference Books:

1. Writing Test benches: Functional Verification of HDL Models, Second edition, Janick Bergeron, Kluwer Academic Publishers, 2003.
2. Principles of Functional Verification, Andreas S. Meyer, Elsevier Science, 2004
3. Donald Thomas, "Logic Design and Verification Using SystemVerilog", CreateSpace Independent Publishing Platform, 2014.
4. Assertion-Based Design, 2nd Edition, Harry D. Foster, Adam C. Krolnik, David J. Lacey, Kluwer Academic Publishers, 2004.

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester :**	**II**
Course :	**Professional Elective Lab-II**				**Code :**	**MET 2406**
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
2	2	1	50	--	50	50

Prior Knowledge of

1. Basics of VLSI Design Flow, Basics of FPGA, Basics of Embedded Systems and ComputerNetwork
2. Basics of VHDL, Embedded C, Python andMATLAB

Is Essential

Objectives:

1. To provide students implementation approaches of FPGA design in view of reconfiguration
2. To develop comprehensive approach towards building small low cost embedded IoT system.
3. To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.
4. To understand, design and model various automotive control systems using Model based development technique.
5. To enhance programming skills of students in the field of VLSI and Embedded Systems

Outcomes: On completion of the course, student will be able to:

1. Understand significance of hardware and software co-design principle.
2. Implement an architectural design for IoT for specified requirement.
3. Understand the role of computer-aided design (CAD) tools in automating the design flow and providing improved productivity in VLSI systems design.
4. Develop, simulate and integrate control algorithms for integration of processor design.
5. Program various applications using Front End and Backend Tools, MATLAB, Python and C.
6. Compare and select Linux and embedded Linux utilities with respect to real time applications.

Guidelines :

1. Total 6 experiments to be conducted along with one experiment of for Hardware and Software training and Introduction from Part A and Part B.

2. Total 8 experiments of 30 hours.

Detailed Syllabus:

Part A: Elective III- Reconfigurable Computing **(ANY Three)**	
Expt.	**Description**
1.	Implementation of Audio/Image /Video processing using Digital Signal Processor. Introduction to FPGA tool Flow with case study: 4 bit ALU
2.	Top level modular and hierarchical designs of Adder and Subtractor such that they can be replaced.
3.	Design of adaptive LED shifter which shifts in Right or Left shift using a selector
4.	Design of Multi Context (4) 4-LUT using HDL and implement on FPGA.
Part A: Elective III- IOT in Embedded System (ANY Three)	
Expt.	**Description**
1.	Weather forecasting system using any cloud applications and IoT hardware platforms.
2.	Smart Agriculture irrigation System.
3.	Motion detection-based Intrusion detection and alert system.
4.	Smart Air pollution monitoring system.

Part A: Elective III - ASIC Design (ANY Three)	
Expt.	**Description**
1.	Introduction to SPICE simulation and coding of NMOS/CMOS circuit Write HDL code to simulate with test benches, synthesis, place & route **FIFO** on Programmable ASIC.
2.	Draw CMOS layout in selected technology, simulate with and without capacitive load, comment on rise, and fall times.
3.	To detect stuck at fault, perform fault Simulation and generate test vectors of given model.
4.	Write HDL code for BIST.
Part A: Elective III- Hardware and Software Co-design **(ANY Three)**	
Expt.	**Description**
1.	Design and implement Instruction Set and ALU Design based architecture.
2.	Design and implement architecture to load parallel data and to perform the right or left shift operation.
3.	Design and implement serial-input serial-output register used to establish serial data communication.
4.	Design and implement Adaptive UART.
Part B: Elective IV- Embedded System for Automotive Applications **(ANY Three)**	
Expt.	**Description**
1.	Study of 32-bit automotive grade controller board. Writing code in IDE. Flashing code & testing.
2.	Introduction to Simulink and SimDriveline for modelling an automotive control system.
3.	Deploy a control algorithm on a real-time target. Download the software from Host Machine to target Machine.
4.	Implement any one application prototype from below: Adaptive cruise control, Engine Management System, Power windows and automotive lighting system, etc.
Part B: Elective IV- Embedded Systems in Biomedical Applications **(ANY Three)**	
Expt.	**Description**
1	Design and implement DWT for EEG / ECG Signal Processing using MATLAB / Python
2	Design and implement HRV detection using MATLAB / Python
3	Design and implement any abnormality detection in brain using MRI or fMRI (MATLAB / Python / OMAP)
4	Design and implement real time invasive/ non-invasive glucose measurement system using PSoC or OMAP
Part B: Elective IV- VLSI Testing and Design for Testability **(ANY Three)**	
Expt.	**Description**
1.	Evaluate SSF, MSF and Bridging Faults using backend tools
2.	Design Automatic Test Pattern Generator for 4 bit adder using Xilinx ISE
3.	Writing Test cases for testing combinational circuit.
4.	Case Study: Verification of processor architecture

Part B: Elective IV- System Verilog for Verification (ANY Three)	
Expt.	**Description**
1.	Write a test bench in System Verilog to verify ALU.
2.	Write a test bench in System Verilog to verify Synchronous Up-Down Counter.
3.	Write a System Verilog program which implements Interfaces and Modports .
4.	Verify FIFO using System Verilog assertion.

Text Books:

1. G. D. Micheli, Synthesis and Optimization of Digital Circuits. McGraw Hill, 1994.
2. Xilinx ISE Simulation Guide https://www.xilinx.com/support/documentation/sw_manuals/xilinx14_7/sim.pdf

Reference Books:

1. Naveed Shervani, "Algorithms for VLSI physical design Automation", Kluwer Academic Publisher, Second edition.
2. Bushnell M L, Agrawal V D, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers.

3. Douglas J. Smith, “Hdl Chip Design - A Practical Guide for Designing, Synthesizing & Simulating ASICs & FPGAs Using VHDL or Verilog (1998),
4. Vijay Madisetti, ArshdeepBahga, “Internet of Things: A Hands-On Approach”
5. Christopher Hallinan, “Embedded Linux Primer: A practical real world approach”, Prentice Hall, 2007.

Program:	M. Tech (All branches)			Semester :	II
Course :	Skill Development Lab–II(Oral &Written Communication)			Code :	M_2101

Teaching Scheme			Evaluation Scheme			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
2	2	1	50	--	--	50

Prior Knowledge: Basic Communication skills

Objectives:

1. To facilitate holistic growth
2. To make the students aware about the significance of Soft Skills and English Aptitude
3. To develop the ability of effective communication through individual and group activities
4. To expose students to right attitude and behavioral aspects and build the same through various activities

Outcomes:

After learning the course the students should be able to:

1. Express effectively through verbal/oral communication skills
2. Prepare for group discussions/meetings/interviews and presentations
3. Operateeffectivelyinmultidisciplinaryandheterogeneousteamsthroughtheknowledgeofteamwork,inter personal relationships, conflict management and leadership activities

Guidelines :

1. All experiments are compulsory.

Detailed Syllabus:

Skill Development Lab

Expt.	Description
1.	**Group Discussion:** Make students aware of proper and globally accepted ethical way to handle work, colleagues and clients. Develop group communication skills. Learn to speak up one‘s opinion in a forum. Cultivate the habit of presenting solution-driven analytical arguments making them contributors in any team.
2.	**Public Speaking:** Any one of the following activities may be conducted : **1. Prepared speech** (Topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver.) **2. Extempore speech** (Students deliver speeches spontaneously for 5 minutes each on a given topic)
3.	**Writing An Article On Any Social Issue:** Build writing skills, improve language and gain knowledge about how to write an article/ report
4.	**Reading and Listening skills:** The batch can be divided into pairs. Each pair will be given a article by the facilitator. Each pair would come on the stage and read aloud the article one by one. After reading by each pair, the other students would be asked questions and needful corrections in the article. The facilitator can evaluate the students for reading and listening skills.
5.	**Debate On Current Affairs/ Social Relevance Topics:** Cultivate the habit to present forceful arguments while respecting the opponents perspective and enhance verbal skills.
6.	**Telephonic etiquettes:** To teach students the skills to communicate effectively over the phone. Students will be divided into pairs. Each pair will be given different situations, such as phone call to enquire about job vacancy, scheduling a meeting with team members, phone call for requesting of urgent leave from higher authorities. Students will be given 10 min to prepare. Assessment will be done on the basis of performance during the telephone call.
7.	**Email etiquettes:** To provide students with an in-depth understanding of writing formal emails.
8.	**Mock interviews:** Guide students and conduct mock interviews

Text Books:

1. BarunMitra, Personality Development and SoftSkills
2. *Stephen Lucas,The Art of PublicSpeaking*

Reference Books:

1. Marcia Weaver,Empowering Employees Through BasicSkills
2. Gerald Ratigan, Aced: Superior Interview Skills to Gain an Unfair Advantage to Land Your DREAMJOB!

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester :**	**II**
Course :	**Integrated Mini-Project**				**Code :**	**MET2701**
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
6	6	3	50	--	50	100

Prior Knowledge of

1. Basics of Electronics Circuits, VLSI and Embedded
2. Basics of C, MATLAB,VHDL

Is Essential.

Objectives:

1. To understand the ―Product Development Process‟ including budgeting through Mini Project.
2. To plan for various activities of the project and channelize the work.
3. To build, design and implement real time application using available platforms

Outcomes:

After learning the course the students should be able to:

1. Understand, plan and execute a Mini Project.
2. Design real time application
3. Prepare a technical report based on the Mini project.
4. Deliver technical seminar based on the Mini Project work carried out.

Guidelines : Total : 45 contact hours

1. Individual student need to design and demonstrate Mini-project under the guidance of allocated guide.
2. Students can choose platform of VLSI or Embedded system considering their future implementation in Major Project in second year
3. The hardware implementation on the board and software simulation is compulsory.
4. Mini-Project Report should be submitted as a compliance of term work associated with subject.
5. Paper publication associated with mini-project as research outcome is appreciable.
6. Mini-project work preferably should be completed in laboratory.
7. **Students should spend 36 hours for experimentations**

Detailed Syllabus:

Integrated Mini-Project

Sr. No.	**Activity**	**Duration (Hrs)**
1.	Week 1 &2 : Mini-project guide allotment, finalization of topic and platform, Planning of the work	**8**
2.	Week 3&4: Literature review and specification and Methodology Finalization, Review 1 for finalization of topic and specification.	**8**
3.	Week 5&6 : Simulation of Idea on appropriate software tools and finalization of hardware platform	**8**
4.	Week 7 &8 : understanding platform implementation and related software flow and execute block level design , Review 2 to understand the progress of the project	**8**
5.	Week 9 & 10: Mini Project Report writing and publication or copyright planning and execution.	**6**
6.	Week 11&12: Demonstration of Project work and Final Review for submission and term work compliances.	**7**
	Total	**45**

Reference:

1. Robert Boylested,, Essentials of Circuit Analysis, PHI Publications
2. Thomas C Hayes,Paul Horowitz, The Ar tof Electronics Newens Publication
3. A.E.Ward, Angus,, Electronic Product Design, Stanley Thornes Publishers, UK.

Syllabus of S.Y.M.Tech Courses (Approved by E&TC BOS)

(Course 2020)

Course Syllabus

Semester-III

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester :**	**III**
Course :	Dissertation Phase – I [Company/ In-house project]				**Code :**	**MET3702**
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**IE-I**	**TW**	**OR**	**Total**
20	20	10	-	100	100	200

Pre-requisite:

1. Basics of Electronics Circuits, VLSI and Embedded
2. Basics of C, MATLAB, VHDL,python.

Objectives:

1. To understand the ―Product Development Process‟ including budgeting.
2. To plan for various activities of the major project and channelize the work towards product development.
3. To build, design and implement real time application using available platforms.
4. To inculcate research culture in students for their technical growth.

Outcomes:

After learning the course the students should be able to:

1. Understand, plan and execute the major Project with appreciable research outcomes.
2. Design real time application considering immerging areas in technology
3. Prepare good quality technical report based on the project.
4. Demonstrate technical ideas and its relevance in recent technology
5. Publish good quality paper in reputed journal and present their work in reputed conferences.

Guidelines :

1. Individual student need to design and demonstrate project under the guidance of allocated guide.
2. Sponsored Project or Project Internship is acceptable considering postgraduate scope.
3. Students can choose platform of VLSI or Embedded system considering recent trends and societal importance.
4. The hardware and software implementation is compulsory.
5. Project Report-1 should be submitted as a compliance of term work associated with subject.
6. At least 2 Paper publications are expected as research outcome of Project Stage-I (Conference or reputed journal) and 40% of planned project work should be completed for submission of Dissertation Phase-I

Detailed Syllabus:

Project Activities

Sr. No.	**Activity**	**Duration (Hrs)**
1.	Week 1 &3 : Guide allotment, applying for sponsorship and project internship, finalization of topic and platform, Planning of the work.	**30**
2.	Week 4&5: Literature review, Specification and Methodology Finalization, Review 1 for finalization of topic and specification.	**30**
3.	Week 6& 8 : understanding platform implementation and related software flow and execute block level design , Review 2 to understand the progress of the project	**30**
4.	Week 9&10 : Simulation of proposed methodology on appropriate software tools and finalization of hardware platform	**30**
5.	Week 11 & 12: Project Report writing and publication or copyright planning and execution. Demonstration of Project work and Final Review for submission and term work compliances	**30**
	Total	**150**

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester :**	**III**
Course :	**Seminar**				**Code :**	**MET3703**
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**PR**	**TW**	**OR**	**Total**
4	4	2	--	50	50	100

Guidelines :

1. Individual student need to study recent topics in the field of VLSI and Embedded Systems under the guidance of allocated guide.
2. Students can choose topic related to VLSI or Embedded system considering recent trends and its societal importance.
3. The extensive Literature Survey, Mathematical Modeling of particular method and valuable conclusion is expected from seminar study.
4. Seminar Report should be submitted as a compliance of term work associated with subject.
5. At least, one review paper publication is expected as research outcome of seminar.

.

Detailed Syllabus:

Seminar Activities

Sr. No.	**Activity**	**Duration (Hrs)**
1.	Week 1 &3 : Guide allotment, finalization of topic, Planning of the work. Review-1 conduction	**6**
2.	Week 4&5: Literature review, Specification and Methodology Finalization, of detail topic.	**4**
3.	Week 6& 8 : Detail Topic Mathematical model, methodology and findings Review-2 conduction	**6**
4.	Week 9&10 : Comparison of detail topic with other existing methods	**4**
5.	Week 11 & 12: Seminar Report writing and publication or copyright planning Final Review conduction.	**4**
	Total	**24**

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester :**	**III**
Course :	Internship [Company/Inhouse project]				**Code :**	**MET3801**
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**IE1**	**TW**	**OR**	**Total**
4	4	2	-	100	--	100

Guidelines :

1. Individual student need to need to attempt for internship with help of PCCOE T&P cell in the field of VLSI and Embedded Systems under the guidance of allocated guide.
2. If not get selected for any internships, students can choose extension of mini-project / opportunity of Entrepreneurship opportunity from PCCOE topic related to VLSI or Embedded system considering recent trends and its societal importance.
3. The idea presentation is expected from the students based on their topics.
4. Internship Report should be submitted as a compliance of term work associated with subject.

Detailed Syllabus:

Internship/ In-house Projects/ Entrepreneurship activities

Sr. No.	**Activity**	**Duration (Hrs)**
1.	Week 1 &3 : Guide allotment, Application of internships, finalization of topic, Planning of the work. Review-1 conduction	**6**
2.	Week 4&5: Internship/ Mini-project/ Entrepreneurship activity implementation as per requirements	**4**
3.	Week 6& 8 : Review-2 of Activities	**6**
4.	Week 9&10 : Interaction of Guides with Industry, Poster Presentation	**4**
5.	Week 11 & 12: Internship Report writing and publication or copyright planning Final Review conduction.	**4**
	Total	**30**

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester :**	**III**
Course :	MOOCs/ Entrepreneurship				**Code :**	**MET3981**
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**IE1**	**TW**	**OR**	**Total**
4	4	2	-	100	-	100

Guidelines :

1. Individual student need to register for MOOC course of their interest or Entrepreneurship related trainings.
2. Week assignment needs to be regularly completed as per requirement of course, which will be considered for internal assessment of course.
3. The certification of course or training is mandatory.
4. Oral and Presentation of course/ training will be taken at the end of semester
5. Total Duration: 24 Contact Hours and 24 Hours should be spend by students on completion of related activities and requirements.

Course Syllabus

Semester-IV

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester :**	**IV**
Course :	Dissertation Phase – II [Company/ In-house project]				**Code :**	**MET4704**
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**IE-I**	**TW**	**OR**	**Total**
24	24	12	-	200	200	400

Pre-requisite:

1. Basics of Electronics Circuits, VLSI and Embedded
2. Basics of C, MATLAB, VHDL,python.

Objectives:

1. To understand the Product Development Process including budgeting.
2. To plan for various activities of the major project and channelize the work towards product development.
3. To build, design and implement real time application using available platforms.
4. To inculcate research culture in students for their technical growth.

Outcomes:

After learning the course the students should be able to:

1. Understand, plan and execute the major Project with appreciable research outcomes.
2. Design real time application considering immerging areas in technology
3. Prepare good quality technical report based on the project.
4. Demonstrate technical ideas and its relevance in recent technology
5. Publish good quality paper in reputed journal and present their work in reputed conferences.

Guidelines :

1. Semester III major project is continue to be completed in this section under the guidance of same project guides.
2. Students need to implement the project using suitable hardware and software platforms
3. Final Project Report including all process of project should be submitted as a compliance of term work associated with subject and permission to appear for examination.
4. Total 2 Paper publications are expected as research outcome of Project Stage-I and II (Conference or reputed journal) and 100% of planned project work should be completed for submission of Dissertation Phase-I

Detailed Syllabus:

Project Activities

Sr. No.	**Activity**	**Duration (Hrs)**
1.	Week 1 &2 : 60 % Work should be completed.	**30**
2.	Week 3&4: Software Simulation and Hardware Implementation should be completed. Review 1 conduction.	**30**
3.	Week 5& 6 : Paper Publication should be in process or completed during this week, 80% work should be completed.	**30**
4.	Week 7&8 : Compliance of 100 % work. Review -2 will be conducted	**30**
5.	Week 9 & 10: Department Reviews will be conducted to check the quality of project and requirements fulfillment to permit project submission.	**30**
6.	Week 11 & 12: Project Report writing and copyright planning and execution. Demonstration of Project work and Final Research Review Committee (RRC) reviews will be conducted for submission and term work compliances	**30**
	Total	**180**

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester :**	**IV**
Course :	MOOCs/ Entrepreneurship				**Code :**	**MET4982**
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**IE1**	**TW**	**OR**	**Total**
4	4	2	-	100	-	100

Guidelines :

1. Individual student need to register for MOOC course of their interest or Entrepreneurship related trainings.
2. Week assignment needs to be regularly completed as per requirement of course, which will be considered for internal assessment of course.
3. The certification of course or training is mandatory.
4. Oral and Presentation of course/ training will be taken at the end of semester
5. Total Duration: 24 Contact Hours and 24 Hours should be spend by students on completion of related activities and requirements.

"There are no secrets to success. It is the result of preparation, hard work, learning from failure."

– Colin Powell

Annexure-I
AUDIT COURSESyllabus

List of AUDIT COURSE (Common to all Programs)

	SEM-I		SEM-II
M_1961A	Constitution of India	**M_2962A**	Team Building & Leadership
M_1961B	Value Education	**M_2962B**	English for Research writing
M_1961C	Stress Management	**M_2962C**	Disaster Management

Program: M.Tech					**Semester:** I and II	
Course : Audit Courses (Semester I and II)					**Code:** M_1961 , M_2962	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
1	1	--	--	--	--	--

Guidelines:

1. The audit courses are common to all M. Techprograms
2. Students can select any audit course from list of audit courses for Semester I andII
3. These are non-credit courses but mandatory to comply with for the completion of thesemester.

Program	M.Tech(All Branches)/MCA				Semester:	I
Course	Constitution of India				Code :	M_1961A
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
1	**1**	**-**	**--**	**--**	**--**	**--**

Objectives:

1. To understand the constitution and the centre-state relations and functioning
2. To understand the rules and regulations under which public and private sector work
3. To understand E-governance through computers and knowledge of cyber laws

Outcomes:

After learning the course, the students should be able to:

1.Understand the functions of the Indian government and identify and explore the basic features,modalities about Indian constitution and assessment of the Parliamentary System in India.

2.Differentiate the functioning of Indian Political system at Central and State level and comprehend the fundamental rights and abide the rules of the Indian constitution.

Detailed Syllabus:

Unit	Description	Duration (Hrs)
1	Introduction to Constitution & System of Government Meaning of the constitution law and constitutionalism, making of constitution, Salient features and characteristics of the Constitution of India, Preamble, Fundamental Rights, Directive Principles of State Policy, Fundamental Duties and it's legal status, Citizenship. Structure and Function of Central Government, President, Vice President, Prime Minister, Cabinet, Parliament, Supreme Court of India, Judicial Review, Federal structure and distribution of legislative and financial powers between the Union and the States, local self-government	**6**
2	Judiciary and Constitution Functions: Governor, Chief Minister, Cabinet, State Legislature Judicial System in States, High Courts and other Subordinate Courts, Parliamentary Form of Government in India. Constitution Functions: Indian Federal System and it's characteristics, Center& State Relations, President's Rule, Constitutional Amendments and powers, Constitutional Functionaries, Emergency Provisions, Assessment of working of the Parliamentary System in India.	**6**

Text Books:

1. Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi,24th edition, 2020, ISBN-109388548868

2. Clarendon Press, Subhash C, Kashyap, "Our Constitution: An Introduction to India's Constitution and constitutional Law", NBT, 5th edition, 2014, ISBN-9781107034624

Reference Books:

1.Dr J N Pandey : Constitutional Law of India

2. https://www.meity.gov.in/divisions/national-e-governance-plan

2. https://www.meity.gov.in/DeitY_e-book/e-gov_policy/download/Policy%20Document.pdf

3. http://www.iibf.org.in/documents/cyber-laws-chapter-in-legal-aspects-book.pdf

4. Maciver and Page, "Society: An Introduction Analysis ", Laxmi Publications, 4th edition, 2007, ISBN-100333916166

5. PM Bhakshi, "The constitution of India", Universal Law Publishing - An imprint of Lexis Nexis, 14th edition, 2017, ISBN-108131262375

Program	M.Tech(All Branches)/MCA				**Semester:**	I
Course :	Value Education				**Code :**	M_1961B
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
1	**1**	**-**	**--**	**--**	**--**	**--**

Objectives:

1. To identify and develop Attitude and Core Faith values
2. To expose students to Family Relations
3. To enable student to understand Creative Thinking and Problem solving
4. To enable students to understand Humanistic Education.

Outcomes:

After learning the course the students should be able to:

1. Change in awareness levels, knowledge and understanding of student
2. Change in attitudes / behaviour of students with regards to their education improved teamwork, institutional leadership and other life skills
3. Improvement in social health and attitude.

Detailed Syllabus:

Unit	**Description**	**Duration h**
1	Why Human Relations are so important? Understanding Behaviour, Human Relations, and Performance, Personality, Stress, Learning, and Perception, Attitudes, Self-Concept, Natural acceptance of human values, and Ethics, Dealing with Conflict, Leading and Trust	**6**
2	Justice in Humankind, Nurturing and Exploitation, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics	**6**
	Total	**12**

Text Books:

1. A Foundation Course in Human Values and Professional Ethics" R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi and Teacher's Manual, R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi

Reference Books:

1. Human Relations in Organizations Applications and Skill Building" RobartLussier, eighth edition, McGraw-Hill (2014).
2. Atkinson and Hilgard's, "Introduction to psychology" Nolen-Hoeksema, S., Fredrickson, B. L., Loftus, G. R., & Lutz, C., Cengage Learning EME.

Program	M.Tech(All Branches)/MCA		**Semester:**	I
Course :	Stress Management		**Code :**	M_1961C

Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE 1**	**IE 2**	**ETE**	**Total**
1	**1**	**-**	**--**	**--**	**--**	**--**

Objectives:

1. To overcome stress
2. To achieve overall health of body and mind
3. To learn to achieve the highest goal happily
4. To become a person with stable mind, pleasing personality and determination

Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve working efficiency

Detailed Syllabus:

Unit	**Description**	**Duration hr**
1	Definitions of Eight parts of Yog. (Ashtanga) Yam and Niyam. Do`s and Don't's in life.	**6**
2.	Pranayam Regularization of breathing techniques and its effects- Types of pranayama Approach to day to day work and duties, wisdom	**6**
	Total	**12**

Text Books:

1. Yogic Asanas for Group Tarining-Part-I" : Janardan Swami YogabhyasiMandal, Nagpur

Reference Books:

1. Swami Vivekananda, Rajayoga or conquering the Internal Nature, AdvaitaAshrama (Publication Department), Kolkata
2. WendelinKüpers, David J. Pauleen, A Handbook of Practical Wisdom Leadership, Organization and Integral Business Practice, 2016
3. A Foundation Course in Human Values and Professional Ethics Presenting a Universal Approach to Value Education - Through Self-exploration

Program	M.Tech(All Branches)/MCA				Semester:	II
Course:	Team Building & Leadership				**Code:**	M_2962A
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
1	**1**	**-**	**--**	**--**	**--**	**--**

Objectives:

1. Develop and strengthen interpersonal skills
2. Become familiar with and discuss different leadership models.
3. Familiarize students with the characteristics of team building.

Outcomes:

After learning the course, the students should be able to:

1. Use leadership and teamwork knowledge to develop projects.
2. To develop the capacity to work collaboratively in a team

Detailed Syllabus:

Unit	**Description**	**Duration h**
3.	**Leadership:** Will and motivation, Personal leadership, self-knowledge, and self-control, using power responsibly and respectfully: the leader as a team-builder, Ability to plan future actions and transmit that vision to others. Taking the initiative and stimulate others. What the word "leader" means, Types of leadership, Traditional, legal, and legitimate leader. Categories: autocratic, democratic, charismatic, paternalistic, authentic, spiritual, dictatorial, etc.	**6**
2.	**Team work** Why is teamwork important? The evolution from group to team: development stages. Advantages and disadvantages of teamwork. How to determine roles in a team. Traditional vs. virtuoso teams, forming effective and balanced teams, Strengthening teams within the organization. Creating a friendly and collaborative environment. Strategies to develop the team's mission, vision, values, and objectives. Shared objectives vs. personal motivation. Distinguishing purpose and tasks in the team. Encouraging participation. Creating team identity, creating high-performing teams.	**6**
	Total	**12**

Text Books

1. Stephen Covey, The Seven Habits of Highly Effective People, Free Press, 1989.
2. Ronald A. Heifetz, Leadership without Easy Answers, Belknap Press, 1994.
3. Michael E. Porter, Competitive Strategy, Free Press, 1980.

Reference Books:

1. John Kotter, Leading Change: Why Transformation Efforts Fail,
2. IkujiroNonaka, The Knowledge-Creating Company
3. Michael West, The Secrets of Successful Team Management, Chap. 2, "Self-Management," pgs. 32-61

Program	M.Tech(All Branches)/MCA		Semester:	II		
Course :	English For Research Paper Writing		**Code :**	M_2962B		
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
1	**1**	**-**	**--**	**--**	**--**	**--**

Objectives:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
4. Ensure the good quality of paper at very first-time submission

Outcomes:

After learning the course the students should be able to:

1. **Develop the ability to plan and prepare and research papers and reports**
2. **Write a research article, review article, thesis chapter and other related academic research text effectively**

Detailed Syllabus:

Unit	**Description**	**Duration h**
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness, Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Writing the Introduction,Review of the Literature, Methods, Results, Discussion, Conclusions, TheFinal Check.	**6**
2	Key skills needed: Title, Abstract, Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	**6**
	Total	**12**

Text Books:

1. Dey R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

Reference Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
3. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Program	M.Tech(All Branches)/MCA		Semester:	II		
Course :	Disaster Management		Code :	M_2962C		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE-1	IE2	ETE	Total
1	1	-	--	--	--	--

Objectives:

1. To orient engineers about various natural and manmade disasters.
2. To teach the concept of Disaster management and measures to be taken at different stages of disaster management.
3. To provide insight about global, national and regional level scenario of disaster management.

Outcomes:

After learning the course the students should be able to:

1. Learn different disasters and measures to reduce the risk due to these disasters.
2. Learn institutional frame work for disaster management at national as well as global level.

Detailed Syllabus:

Unit	Description	Duration h
1.	**Introduction** – Hazard and Disaster. Concepts of Hazard, Vulnerability, Risks. Different Types of Disaster : A) Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc B) Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures(Building and Bridge), War & Terrorism etc. Slow Disasters (famine, draught, epidemics) and Rapid Onset Disasters(Air Crash, tidal waves, Tsunami) Causes, effects and practical examples for all disasters.	6
2.	**Natural disasters**- Earthquakes, Tsunami, Floods, Drought, Landslides, Cyclones and Volcanic eruptions. Their case studies. Coastal disasters. Coastal regulation Zone. **Disaster Prevention and Mitigation**. Refugee operations during disasters, Human Resettlement and Rehabilitation issues during and after disasters, Inter-sectoral coordination during disasters, Models in Disasters. **Disaster Management** : Role of Government, International and NGO Bodies. Role of IT in Disaster Preparedness Role of Engineers on Disaster Management.	6
	Total	12

Reference Books:

1. Pandey, M., 2014. Disaster Management, Wiley India Pvt. Ltd., 240p.
2. Tushar Bhattacharya, Disaster Science and Management, McGraw Hill Education (India) Pvt. Ltd
3. Jagbir Singh, Disaster, Management: Future Challenges and Opportunities, K W Publishers Pvt. Ltd.
4. J.P. Singhal, Disaster Management, Laxmi Publications
5. C. K. Rajan, NavalePandharinath, Earth and Atmospheric Disaster Management : Nature and Manmade, B S Publication
6. ShaileshShukla, ShamnaHussain, Biodiversity, Environment and Disaster Management, Unique Publications

Text Books:

1. Disaster Administration and Management, Text & Case studies- SL Goel-Deep and Deep Publications
2. Disaster Management- G.K Ghosh-A.P.H. Publishing Corporation
3. Disaster management – S.K.Singh, S.C. Kundu, Shobha Singh A – 119, William Publications, New Delhi.
4. Disaster Management – Vinod K Sharma- IIPA, New Delhi,1995
5. Encyclopedia of Disaster Management- Goel S.L. - Deep and Deep Publications, New Delhi, 2006.

Annexure-II
Open Elective Syllabus

LIST OF OPENELECTIVES

OFFERED BY VLSI & EMBEDDED SYSTEMS

	Open Elective – I		**Open Elective –II**
MET1601A	Automotive Electronics & Applications	**MET2602A**	Drone Programming for Beginners
MET1601B	Industrial Drives	**MET2602B**	Instrumentation and Measurement
MET1601C	Basics of FPGA and CPLD	**MET2602C**	Microcontrollers and Microprocessors applications
MET1601D	Robotics	MET2602D	Electronics Implementation Platforms

OFFERED BY HEAT POWER ENGINEERING

	Open Elective – I		**Open Elective –II**
MMH1601A	Electronic Cooling	**MMH2602A**	Waste Management for Smart Cities
MMH1601B	Green Buildings	**MMH2602B**	Battery Management for Electric Vehicles
MMH1601C	System Modeling and Simulation	**MMH2602C**	Renewable Energy Sources

OFFERED BY DESIGN ENGINEERING

	Open Elective – I		**Open Elective –II**
MMD1601A	Advanced Materials	**MMD2602A**	Room Acoustics
MMD1601B	Optimization Methods	**MMD2602B**	Design Thinking
MMD1601C	Modeling & Simulation of Dynamic Systems	**MMD2602C**	Reliability Engineering

OFFERED BY COMPUTER ENGINEERING

	Open Elective – I		**Open Elective –II**
MCE1601A	Programming with Python	**MCE2602A**	Image Processing with MATLAB
MCE1601B	Software Engineering Basics	**MCE2602B**	Linux Essentials
MCE1601C	Basics of Machine learning	**MCE2602C**	Design with UML

OFFERED BY CIVIL- CONSTRCTION MANAGEMENT

	Open Elective – I		**Open Elective –II**
MCI1601A	Project Management and Finance	**MCI2602A**	Contracts, Tendering and Arbitration
MCI1601B	Green Technology	**MCI2602B**	Total Quality Management in Construction
MCI1601C	Organisation Behaviour	**MCI2602C**	Operation Research

OFFERED BY ARTIFICIAL INTELLIGENCE & DATA SCIENCE

	Open Elective – I		**Open Elective –II**
MDS1601A	R programming	**MDS2602A**	Python for Data Science
MDS1601B	Business Analytics	**MDS2602B**	Introduction to Neural Networks

Program: M. Tech (E&TC)-VLSI and Embedded Systems					**Semester:** I	
Course: Automotive Electronics and its Applications					**Code:** MET1601A	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	**2**	**2**	**20**	**--**	**30**	**50**

Prior Knowledge of Electronics& electrical, instrumentation, control systems, and IC engine operation, **is essential.**

Objectives:

1. To explain the various application of electronics systems and ECU in automotive.
2. To deliver knowledge about principles and applications of sensors and actuators in automotive electronics systems.
3. To explore various control systems in automotive

Outcomes:

After learning the course, the students should be able to:

1. Acquire an overview of automotive components, subsystems, and basics of electronic control in today's automotive industry.
2. Understand the available automotive sensors and actuators in various electronic control systems.
3. Understand components of engine control system in automotive design.
4. Analyze the safety systems in automotive application

Detailed Syllabus:

Unit	Description	Duration (Hrs)
1.	**Automotive Systems Overview:** Automotive vehicle technology, Present trends in automobiles with emphasis on increasing role of electronics and software, Overview of typical automotive subsystems and components, Body, Chassis, and Powertrain Electronics	**7**
2.	**Sensors and Actuators:** Basic sensor arrangement, Types of sensors such as oxygen sensors, Crank angle position sensors, Fuel metering/ vehicle speed sensors, Flow sensor, Temperature, EGO, Air mass flow sensors, Throttle position sensor, Solenoids, Stepper Motors, Relays, etc.,	**8**
3.	**Engine Control System:** Algorithms for engine control including open loop and closed loop control system, Electronic ignition, EGR for exhaust emission control. Look-up tables and maps, Need of maps, Procedure to generate maps, Engine calibration, Torque table, Dynamometer testing	**7**
4.	**Active and passive safety systems:** Body electronics including lighting control, Remote keyless entry, Immobilizers etc., Electronic instrument clusters and dashboard electronics, Antilock braking system, Electronic stability program, Air bags, Computer vision based ADAS	**8**
	Total	**30**

Text Books:

1. William B. Ribbens, "Understanding Automotive Electronics- An Engineering Perspective", 7th edition, Butterworth-Heinemann Publications, 2017.
2. Ronald K. Jurgen, "Automotive Electronics Handbook", Mc-Graw Hill, 1999

Reference Books:

1. Robert Bosch, "Automotive Hand Book", 10th edition, Wiley Publications, 2018
2. Kiencke, Uwe, Nielsen & Lars, "Automotive Control Systems for Engine, Driveline and Vehicle", Second edition, Springer Publication, 2005.
3. Tom H. Denton ,"Automobile Electrical and Electronic Systems", 3rd Edition, Elsevier, 2004
4. John F. Kershaw, James D. Halderman, "Automotive Electrical and Electronic Systems", 5th Edition, Pearson Prentice Hall, 2007

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester:**	**I**
Course:	**Industrial Drives**				**Code:**	**MET1601B**
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE 1**	**IE 2**	**ETE**	**Total**
2	**2**	**2**	**20**	**--**	**30**	**50**

Pre-requisite:
Electrical Drives, Dynamics of Electrical drives, Control Systems

Objectives:

1. To define electric drive, its parts, advantages and explain choice of electric drive.
2. To explain dynamics and modes of operation of electric drives.
3. To explain selection of motor power ratings and control of dc motor using rectifiers.
4. To explain the control of induction motor, synchronous motor and stepper motor drives.
5. To discuss typical applications electrical drives in the industry

Outcomes:
After learning the course, the students should be able to:

1. Analyze the performance of induction motor drives under different conditions.
2. Control induction motor, synchronous motor and stepper motor drives.
3. Suggest a suitable electrical drive for specific application in the industry
4. To analyze the performance of induction motor drives under different conditions.

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs)**
	Selection of Motor Power Ratings: Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating. **Direct Current Motor Drives:** Controlled Rectifier Fed dc Drives, Single and three Phase Half and Fully Controlled Rectifier Control of dc Separately Excited Motor, Rectifier Control of dc Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Control of Separately Excited dc Motor, Chopper Control of Series Motor.	**7**
	Induction Motor Drives: Analysis and Performance of Three Phase Induction Motors, Analysis of Induction Motor Fed from Non-Sinusoidal Voltage Supply, Starting, Braking, Transient Analysis. Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources.	**8**
	Voltage Source Inverter (VSI) Control, Cyclo-converter Control, Closed Loop Speed Control and Converter Rating for VSI and Cyclo-converter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source (CSI) Control, current regulated voltage source inverter control, speed control of single phase induction motors.	**7**
	Synchronous Motor Drives: Operation from fixed frequency supply-starting, synchronous motor. Self-controlled synchronous motor drive employing load commutated thruster inverter, Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless dc Motor Drives. **Stepper Motor Drives:** Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping Rate Characteristics, Drive Circuits for Stepper Motor. **Industrial Drives:** Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.	**8**
	Total	**30**

Text Books:

1. Gopal K Dubey , Fundamentals of the electrical drives Narosa publication
2. N. Mohan T.M. udeland&W.P.Robbins , Power Electronics converter application J.Wiley& sons
3. VedamSuryavanshi**,** Electrical Drives Concept and application
4. B.K. Bose, Advanced power Electronics & A.C. Drives
5. S.K.Pillar, Analysis of thyristor power conditioned motors

Reference Books:

1. N.K De,P.K. Sen , Electric Drives PHI Learning 1 st Edition, 2009
2. Gobal K.Dubey, Fundamentals of Electrical Drives- Alpha Science Int. Ltd.,
3. Shepherd Hullay&Liag, Power Electronics & Motor Control -, Cambridge Univ. Press
4. Gopal K Dubey, Power Semiconductor controlled Drives, - Prentice Hall pub.
5. R. Krishnan, Electric Motor Drives–Modelling, Analysis and Control, - Pearson Education, 2003
6. P.C. Sen ,Thyristorised DC Drives -, Krieger pub.
7. S.B.Dewan, G.R.Slemon&A.Stranghan; Power Semi conductor controlled Drives - John-Willey pub.

Program:	M.Tech (E&TC)-VLSI and Embedded Systems				Semester :	I
Course :	Basic of FPGA and CPLD				Code :	MET1601C
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of Is Essential. Fundamentals of digital electronics, Knowledge of one hardware description language

Objectives:

1. To make students familiar with programmable logic devices and its architectures.
2. To understand the architecture and features of FPGA and CPLD .
3. To make the students familiar with the design process and how the design is mapped to the existing hardware in FPGA and CPLD.

Outcomes:

After learning the course the students should be able to:

1. To understand the depth of CPLD and FPGA architectures.
2. To design a system using FPGAs.
3. To demonstrate an understanding of interfacing of different external devices with FPGA/CPLD.
4. To apply the complete design flow of FPGA and CPLD for the specific application.

Detailed Syllabus:

Unit	Description	Duration H
1.	**Introduction:** Introduction to Hardware Description language, Need of Programmable logic devices, PLA PAL, CPLD, FPGA: General Architecture, features CPLD Architecture: overview, specification and applications, Features of XC9500 series of CPLD family.	**7**
2.	**FPGA Architecture:** Xilinx Logic Cell Array, Configurable Logic Block, I/O Block, Programmable Interconnects, Programming methods, Advanced features of Xilinx 4000 series Technology Trends: Device capacity, Utilization and Gate Density, Programming methods, General Design Flow, General Design Guidelines.	**8**
3.	**Interfacing with FPGA/CPLD:** The purpose of interfacing, interfacing of external devices such as WiFi Module, Bluetooth Module, GPS Module, Zigbee Module, Different types of display devices with FPGA/CPLD	**7**
.	**Case Studies-FPGA/CPLD:** Xilinx Virtex-6, Spartan-6, Z-board Advanced features in FPGA based on Case studies. **Logical Design by FPGA/CPLD:** Complete design of any combinational circuit by gates, Boolean Algebra, Design of sequential circuits	**8**
	Total	**30**

Text Books:

1. P.K.Chan& S. Mourad, Digital Design Using Field Programmable Gate Array, Prentice Hall (Pte), 1994
2. Ronald Sass and Andrew G. Schmidt, "Embedded systems design with platform FPGAs: Principles and practices", Morgan Kaufmann, 2010.
3. Design manuals of Altera, Xilinx and Actel.

Reference Books:

1. S. Trimberger, Edr. Field Programmable Gate Array Technology, Kluwer Academic Publications, 1994.
2. Ronald J Tocci, Neal S. Widmer, Gregory L. Moss, "Digital Systems: Principles & Applications", 10th Edition, Pearson, 2009
3. J. Old Field, R. Dorf, Field Programmable Gate Arrays, John Wiley & Sons, Newyork, Reprint 2008.
4. S. Brown, R. Francis, J. Rose, Z. Vransic, Field Programmable Gate Array, BSP, 2007.
5. S. Brown and J. Rose, "Architecture of FPGAs and CPLDs: A Tutorial", IEEE Design & Test of Computers, Vol. 13, No. 2, pp. 42-57, 1996.
6. Stephen Brown ZvonkoVranesic – Fundamentals of Digital Logic with VHDL design, McGraw Hill – 2000

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester :**	**I**
Course :	**Robotics**				**Code :**	**MET1601D**
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20	--	30	50

Prior Knowledge of

1. Sensors and actuators
2. Programming language 'C', MATLAB

is essential.

Objectives: To impart knowledge on

1. Electromechanical elements of robots
2. Control system for robot automation
3. Existing robots designed for various applications

Outcomes:

After learning the course the students should be able to:

1. Understand kinematics, statistics and dynamic of robots
2. Apply concepts of industrial automation and communication for selection of robots
3. Select sensing and actuating elements for designing robots as per applications requirements
4. Integrate and design control system and information system for various applications.

Detailed Syllabus:

Unit	**Description**	**Duration h**
1.	**Introduction to robotics:**Evolution of Robotics, Elements of robots; Kinematics of serial and parallel robots; Velocity and static analysis of robots; Dynamics of robots; Motion planning and control; Flexible manipulators; Wheeled mobile robots, classification of Robots	**7**
2.	**Advanced concepts in robotics:** Introduction to Cloud and Fog robotics; Basic concepts of industrial automation and communication protocols for PLC, DCS, SCADA systems; Introduction to Internet of Things, Protocols and real time applications.	**8**
3.	Sensing Elements **for robots:** Classification of Sensors, Encoders and Dead Reckoning Infrared Sensors, Ground-based RF Systems, Active Beacons, Ultrasonic Transponder Tri-lateration, Accelerometers, Gyroscopes, Laser Range Finder, Vision-based Sensors, Color-tracking Sensors, safety and motion sensors, Force/ Torque Sensors , Tactile Sensors, DC Motors, Controlling a DC Motor, Pulse Width Modulation, Stepper Motors, Servo Motor.	**7**
4.	Control System of Robots: Automatic-Feedback Control System, Control Elements, Control System Design, A Robot's System Dynamics, Sensory Feedback, Control Algorithms and Performances, Space Control, Introduction to Information System of Robots.	**8**
	Total	**30**

Text Books:

3. John J C, Introduction to Robotics: Mechanics and Control , Addison-Wesley (1989).
4. Appin Knowledge Solutions, Robotics (2007)
5. Ming Xie, Fundamentals of Robotics - Linking Perception to Action (2003)

Reference Books:

10. Thomas Bräunl, Embedded Robotics - Thomas Braunl (2006)
11. Bruno S and Sciavicco L, Robotics: Modelling, Planning and Control, Springer (2009).
12. Fu K S, Ralph G and Lee C S G, Robotics: Control Sensing. Vision, and Intelligence , Tata McGraw-Hill (1987).
13. Mukhopadhyay S, Sen S and Deb A K, Industrial Instrumentation, Control and Automation, Jaico (1999).
14. Rajkumar B and Dastjerdi A V, Internet of Things: Principles and Paradigms , Morgan Kaufmann (2016).

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester:**	**II**
Course:	**Drone Programming for Beginners**				**Code:**	**MET2602A**
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE 1**	**IE 2**	**ETE**	**Total**
2	2	2	20	--	30	50

Prior Knowledge of Basic understanding of physics (Force, Velocity, Acceleration, etc), Understanding of sensors and actuators, Control systems, Modelling Basics –MATLB & SIMULINK, Programming in python **Is Essential**.

Objectives:

1. To understand the physics behind drones
2. To create the mathematical model of quadcopter drone from simple mathematics & Experimental data
3. To implement model into Simulink & check it against real life performance

Outcomes:

After learning the course, the students should be able to:

1. Identify & select different accessories of Drones as per applications
2. Establish the mathematical model & the Physics behind Quadcopter drone
3. Design Simulink model simulating the complete dynamics of quadcopter drone.

Detailed Syllabus:

Unit	**Description**	**Duration H**
1.	**Introduction to drones:** Unmanned Aerial Systems (UAS), Basics of drones, Introduction to Drones programming and Development Tools, Current rules and regulations governing owning and operating a UAS, concerns surrounding UAS safety, security and privacy issues	**7**
2.	**Drone accessories and Applications:** Sensors, Motors, Propellers, Battery, Concept of propulsion, Forces working on a Flight, Principal axes and rotation of aerial systems, Stable, unstable and neutral systems, Control drone (roll, pitch and yaw), Application of drones.	**8**
3.	**Drone control system development in Simulink:** Control system architecture, Quadcopter with actuator & propellers functionality block, Sensing & estimation functionality block, controller functionality block, Motor mixing algorithm (RPYT) functionality block	**7**
4.	**Modelling, Simulation & Flight control design:** Dynamic quadcopter system Model, flight control design, 3D visualization, testing & Tuning the model, Flight operations, Applicable software for data collection, processing, and analysis	**8**
	Total	**30**

Text books:

1. John Baichtal ,Building your own drones, a beginner's guide to drones, UAVS, and ROVs
2. Muhammad Usman , Quadcopter modelling and control with Matlab/Simulink implementation
3. Ryan Gordon , Model based design of a quadcopter
4. K.S.Fu, R.C.Gonzalez, C.G.Lee , Robotics control, sensing, vision and intelligence

Reference Books:

1. - R.K.Mittal , I.J.Nagrath,Robotics and control
2. Ben Rupert , Drones (The ultimate guide), , CreateSpace Independent Publishing Platform
3. Agam Kumar TyagiMatlab and Simulink for engineers, , Oxford University Press, 2012

Program:	**M. Tech (E&TC)-VLSI and Embedded Systems**				**Semester:**	**II**
Course :	**Instrumentation and Measurements**				**Code:**	**MET2602B**
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	**2**	**2**	**20**	**--**	**30**	**50**

Prior Knowledge of Is Essential Basics of sensors and Actuators, Basic of Electronics, Analog and Digital Systems

Objectives:

To impart knowledge on the following Topics -

1. Basic functional elements of instrumentation
2. Fundamentals of electrical and electronic instruments
3. Comparison between various measurement techniques
4. Various storage and display devices
5. Various transducers and the data acquisition systems

Outcomes:

After learning the course, the students should be able to:

1. Analyse different measuring parameters of any electronics/mechatronics system
2. Design and evaluate characteristics of different types of mechatronics/ electrical/ electronic system
3. Understand different types of wave/spectrum analyzer.
4. Interface various system components and analyse its data using data acquisition system.

Detailed Syllabus:

Unit	**Description**	**Duration h**
1.	Basics of Measurements: Accuracy, Precision, resolution, reliability, repeatability, validity, Errors and their analysis, Standards of measurement. Bridge Measurement: DC bridges-wheatstone bridge, AC bridges – Kelvin, Hay, Maxwell, Schering and Wien bridges, Wagner ground Connection. Electronic Instruments for Measuring Basic Parameters: Amplified DC meter, AC Voltmeter, True- RMS responding Voltmeter, Electronic multi-meter, Digital voltmeter, Vector Voltmeter.	**7**
2.	Oscilloscopes: Cathode Ray Tube, Vertical and Horizontal Deflection Systems, Delay lines, Probes and Transducers, Specification of an Oscilloscope. Oscilloscope measurement Techniques, Special Oscilloscopes – Storage Oscilloscope, Sampling Oscilloscope. Signal Generators: Sine wave generator, Frequency – Synthesized Signal Generator, Sweep frequency Generator. Pulse and square wave generators. Function Generators.	**8**
3.	Signal Analysis: Wave Analyzer, Spectrum Analyzer. Frequency Counters: Simple Frequency Counter; Measurement errors; extending frequency range of counters Transducers: Types, Strain Gages, Displacement Transducers	**7**
4.	Digital Data Acquisition System: Interfacing transducers to Electronics Control and Measuring System. Instrumentation Amplifier, Isolation Amplifier. An Introduction to Computer-Controlled Test Systems.IEEE-488 GPIB Bus	**8**
	Total	**30**

Text Books:

1. Albert D.Helstrick and William D.Cooper, Pearson Education , Modern Electronics Instrumentation & Measurement Techniques, . Selected portion from Ch.1, 5-13.

2. by JoshphJ.Carr ,Elements of Electronics Instrumentation and Measurement-3rd Edition.Pearson Education. Selected portion from Ch.1,2,4,7,8,9,13,14,18,23 and 25.

Reference Books:

1. Electronics Instruments and Instrumentation Technology – Anand, PHI

2. Doebelin, E.O., Measurement systems, McGraw Hill, Fourth edition, Singapore, 1990.

Program: M.Tech (E&TC)-VLSI and Embedded Systems				Semester : I		
Course : Microcontrollers and Microprocessors applications				Code : MET2602C		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of Digital Electronics **is essential.**

Objectives:

1. To explain architecture and features of typical Microcontroller.
2. To make students understand need of microcontrollers in real life applications.
3. To explore interfacing of real-world peripheral devices, various hardware and software tools for developing applications.
4. To explain the architecture and programmer's model of advanced processor and microcontroller
5. To acquaint the learner with application instruction set and logic to build assembly language programs.

Outcomes:

After learning the course the students should be able to:

1. Learn importance of microcontroller and microprocessor in designing embedded application
2. To apply the programming skills to develop real-life embedded application.
3. Learn use of hardware and software tools.
4. Develop interfacing to real world devices

Detailed Syllabus:

Unit	Description	Duration h
1.	**Introduction to single chip Microcontrollers:** Intel MCS-51 family features, 8051/8031-architecture, 8051 assembly language programming, addressing modes, Programming interrupts, timers and serial communication	7
2.	**Microcontrollers and system design:** Assembly vs High-Level language programming, System Development Environment: assembler, compiler and integrated development environment, Debugging and Simulation, system design with 8051.	8
3.	**System level interfacing design;** Advanced Microprocessor Architectures- 286, 486, Pentium; Introduction to RISC processors; ARM microcontrollers; Embedded system design methodologies, embedded controller design for communication, digital control.	7
4.	**Microcontroller & Processors Applications:** Interfacing with display devices, Sensors, actuators, and memory devices. Case Study on real time embedded system.	8
	Total	30

Text Books:

1. Barry B Brey, The intel microprocessor: architecture, programming and interfacing, Prentice hall of India, New Delhi, 2003.ISBN-0138027455, 4th Edition
2. Mohammad Ali Mazidi and Janice GillispieMaszidi "The 8051 Microcontroller and Embedded Systems" Pearson education, 2003, ISBN- 9788131710265, 2nd Edition

Reference Books:

1. Chris H. Pappas, William H. Murray, ―80386 Microprocessor Handbooks‖, McGraw-Hill Osborne Media, ISBN-10: 0078812429, 13: 978-0078812422.
3. Walter A. Triebel, ―The 80386Dx Microprocessor: Hardware‖, Software, and Interfacing, Pearson Education, ISBN: 0137877307, 9780137877300.
4. Mohammad Rafiquzzaman, ―Microprocessors: Theory and Applications: Intel and Motorola", Prentice Hall, ISBN: -10:0966498011, 13:978:0966498011.
5. K. Bhurchandi, A. Ray, ―Advanced Microprocessors and Peripherals, McGraw Hill Education, Third Edition, ISBN: 978-1-25-900613-5

Program:	**M. Tech(VLSI & Embedded Systems)**				**Semester: II**	
Course:	**Electronics Implementation Platform**				**Code: MET2602D**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20	--	30	50

Prior Knowledge of C language, Python, electronic circuits **Is Essential**

Objectives:

1. Explain about the Arduino, Raspberry Pi, PLDs and all other associated platforms
2. Understand of the importance of micro controllers and computers in science and technology.
3. Discuss basic programming and structures required for basic operation of the platform,
4. Describe how to recognize functions, operations and syntax of Python, C and C++

Outcomes:

After learning the course, the students should be able to:

1. Apply logical thinking and problem-solving skills with Arduino platform.
2. Acquire knowledge about Raspberry pi for implementation of applications
3. Understand Digital Signal processing implantation basics
4. Understanding rapid prototyping using PLDs.

Detailed Syllabus:

Unit	**Description**	**Duration h**
1.	Arduino: A open-source Hardware, Working, Interfacing, Coding basics and small applications and Debugging.	**7**
2.	Raspberry pi : Working, Interfacing, Coding basics and small applications and Debugging.	**8**
3.	DSP processor for Real time Video and Inage Processing. : Working, Interfacing, Coding basics and small applications and Debugging.	**7**
4.	Programmable Logic devices: FPGA: Working, Interfacing, Coding basics and small applications and Debugging.	**8**
	Total	**30**

Text Books:

1. Ryan Turner,Arduino Programming: The Ultimate Beginner's & Intermediate Guide to Learn Arduino Programming Step by Step, 2019
2. Derek Molloy Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux 1st Edition,2006
3. AvtarSingh , Digital Signal Processing Implementations : Using DSP Microprocessors (with examples from TMS320C54XX),2003
4. Roger Woods, John McAllister, Ying Yi, Gaye Lightbody, FPGA-based Implementation of Signal Processing Systems, Second Edition, 2017

Reference Books:

1. Mark TorvaldsARDUINO - ARDUINO PROGRAMMING - ARDUINO FOR BEGINNERS,Second Edition June 7, 2018
2. Eben Upton Raspberry Pi User Guide 4th Edition 2019
3. Sen M. Kuo ,Real-Time Digital Signal Processing, : Implementations, Application and Experiments with the TMS320C55X, 2001
4. CemUnsalan, Bora Tar ,Digital System Design with FPGA: Implementation Using Verilog andx VHDL ,2017

Program:	M. Tech. Mechanical (Heat Power Engineering)				Semester: I	
Course:	Electronic Cooling				Code: MMH1601A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20		30	50

Prior Knowledge of Thermodynamics, Fluid Mechanics, Heat Transfer**Is Essential**

Objectives:

1. To establish fundamental understanding of heat transfer in electronic equipment.
2. To select a suitable cooling process for electronic components and systems.
3. To increase the capabilities in design and analysis of cooling of electronic packages.
4. To analysis the thermal failure for electronic components and define the solution.

Outcomes:

After learning the course, the students should be able to

1. Understand Heat transfer processes involved in electronics cooling.
2. Analyze thermal failure for electronic components and define the solution.
3. Assign the best cooling method for each individual application.
4. Design cooling system for any electronic device and select Best packaging approach for any design.

Detailed Syllabus:

Unit	Description	Duration h
1.	**Introduction to Electronics Cooling** Introduction, Packaging Trends and Thermal Management, Basics of Heat Transfer, Conduction Heat Transfer, Multi-Dimensional Conduction, Transient Conduction, Natural Convection in Electronic Devices, Forced Convection Heat Transfer, Radiation Heat Transfer, contact and spreading resistances.	07
2.	**Electronics Cooling Methods in Industry** Thermal interface and phase change materials, passive and novel air-cooling approaches, Heat Sinks, Heat Pipes in Electronics Cooling, Thermoelectric Cooling, Liquid Immersion Cooling (Single and Two-phase), Cooling Techniques for High Density Electronics	08
3.	**Packaging of Electronic Equipment** Components of Electronic Systems, Packaging of Electronic Equipment, Conduction Cooling for Chassis and Circuit Boards, Chip/circuit material for augmenting heat transfer.	07
4.	**Control Parameters Measurement and simulation** Temperature & humidity requirement, CFD analysis for Airflow & temperature evaluation, thermography etc	08
	Total	30

Text Books:

1. D. S. Steinberg," Cooling Techniques for Electronic Equipment ", Second Edition, John Wiley & Sons, 1991.
2. F. P. Incropera, "Introduction to Heat Transfer ", Fourth Edition, John Wiley, 2002.
3. S. J. Kim and Sang Woo Lee, "Air cooling Technology for Electronic Equipment", CRC press, London, 1996.
4. F. P. Incropera, "Liquid Cooling of Electronic Devices by Single-Phase Convection", John Wiley& sons, inc, 1999.

Reference Books:

1. J. L. Sloan, "Design and Packaging of Electronic Equipment", Van Nostrand Reinhold Company, 1985.
2. C.Belady, "Standardizing Heat Sink Performance for Forced Convection, Electronics Cooling", Vol. 3, No. 3, September, 1997.
3. C.Biber, Wakefield Engineering, Wakefield, Massachusetts, "Characterization of the Performance of Heat Sinks,", Personal Communication, October 1997.
4. A. B.-Cohen, “Encyclopedia of Thermal Packaging volume 1 to 6”, February 2013, World Scientific Publication

Program:	M. Tech. Mechanical (Heat Power Engineering)					Semester: I	
Course:	Green Buildings					Code: MMH1601B	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE 1	IE 2	ETE	Total
2	-	-	2	20	-	30	50

Prior Knowledge of Basics of air conditioning and Basics of building construction **Is Essential**

Objectives:

1. To develop a multidisciplinary approach to the energy supply and use in new and existing buildings
2. To develop knowledge and understanding of system solutions that provide optimal indoor environment in buildings in an environmentally and cost-effective way
3. To create awareness of different building rating tools

Outcomes:

After learning the course, the students should :

1. Demonstrate understanding of integrated building design process and rating systems for energy efficient buildings
2. Recognize importance of energy and water efficiency as well as waste management strategies
3. Be able to select appropriate site features and evaluate the relationship between energy use and indoor comfort
4. Appreciate the role of material selection in design of green buildings and demonstrate knowledge of government schemes and byelaws for green buildings

Detailed Syllabus:

Unit	Description	Duration, h
1	**Overview and comparison of green building rating systems** What is green building, conventional building practices versus integrated design process, comparison of USGBC LEED, IGBC, GRIHA, EDGE and other green building rating systems, Conducting feasibility studies, reference standards, key definitions, synergies between various credit categories, understanding building forms, site level features, microclimate features	**07**
2.	**Resource Efficiency** Energy efficiency in buildings, Water efficiency – indoor water use, rainwater harvesting, irrigation water use, wastewater systems, strategies for reducing water consumption Waste management – source reduction, reduce – recycle – reuse, strategies for waste management, construction waste management plan	**08**
3	**Health, Wellness and Site features** Introduction to indoor air quality, ASHRAE 62.1 overview and requirements, ventilation rate procedure method, key parameters affecting indoor environment, IAQ management plan Daylight and views, strategies to enhance daylight availability, Overview of WELL standard for buildings, impact of VOCs and hazardous chemicals on human health Erosion and sedimentation control, water efficient landscaping and irrigation practices, microclimate, heat island effect, exterior lighting pollution, Location and transportation, transportation management strategies and planning	**07**
4	**Materials, resources and Government schemes and incentive programs** Low-embodied energy materials, environmental product declarations (EPDs), overview of material categories of IGBC, LEED & GRIHA, life cycle analysis and its application, overview of software tools for LCA Funding and Incentives for green building rating programs, requirements of NBC 2016 related to sustainability, local byelaws, model building code.	**08**
	Total	**30**

Text Books:

1. Shahane, V. S, “Planning and Designing Building”, Poona, Allies Book Stall, 2004.
2. Michael Bauer, Peter Mösle and Michael Schwarz “Green Building – Guidebook for Sustainable Architecture” Springer, 2010.
3. Tom Woolley, Sam Kimmins, Paul Harrison and Rob Harrison “Green Building Handbook” Volume I, Spon Press, 2001.

Reference Books:

1. MiliMajumdar, “Energy-efficient buildings in India” Tata Energy Research Institute, 2002.
2. TERI “Sustainable Building Design Manual- Volume I & II” Tata Energy Research Institute, 2009
3. Reference manuals of green building rating programs (LEED, WELL, IGBC, GRIHA)
4. ASHRAE Standard 62.1, Standard 55, Standard 90.1, and other standards referred by green building programs
5. EDGE App user manual
6. National Building Code of India – 2016
7. ECBC 2017

Program:	M. Tech. Mechanical (Heat Power Engineering)		Semester : I			
Course :	System Modelling and Simulation		Code :MMH1601C			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	-	30	50

Objectives:

1. Students able to model any physical system for realtime applications
2. Students able to simulate any physical system for realtime applications

Outcomes:

After learning the course, the students should be able to:

1. Develop mathematical model for practical problem
2. Develop Bond Graph model for system
3. Apply transfer function and State space model techniques
4. Simulate the system using suitable software and Estimate parameters by optimization

Detailed Syllabus:

Unit	Description	Duration
1.	Introduction to Modelling and Simulation, Basic systems, Introduction and Types of Mathematical modelling, Basic building blocks Mechanical, Electrical, Thermal systems.	7
2.	Bond Graph Modelling of Dynamic Systems: Representation,Elements, Single,Two and multiports Causality, Application to basic Mechanical,Electrical and Electromechanical system	8
3.	Dynamic Response and System Transfer Function: Poles, Stability Block diagram/Signal flow diagram/State Space formulation and Frequency response	7
4.	Simulation and Simulation application Parameter Estimation, System Identification and Optimization	8
	Total	30

Reference Books:

1. Brown, Forbes T. Engineering System Dynamics. New York, NY: CRC, 2001. ISBN: 9780824706166.

Program: M. Tech. (Heat Power Engineering)			Semester: II			
Course: Waste Management for Smart Cities			Code: MMH2602A			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credits	IE 1	IE 2	ETE	Total
2	2	2	20	-	30	50

Course Objective:

1. To provides an in-depth understanding of Municipal waste characteristics and management.
2. To make aware about regulations in the area municipal waste management.
3. To equip with the methods of environment risk assessment of waste.
4. To provide an in-depth understanding of Physiochemical and biological treatment of Municipal waste.
5. To be able to design the land-fields for the smart cities

Course Outcomes: The learners will be

1. Identify and evaluate the sources; composition; generation rates, methods of separation and collection methods of municipal waste treatment.
2. Evaluate and analysis the risk and methods of handling the hazardous and radioactive waste based on health effects.
3. Evaluate the Physiochemical and biological waste for its treatment and disposal
4. Design the land field for solid and hazardous wastes collection and removal

Detailed Syllabus

Unit	Description	Duration, h
1.	Municipal Solid Waste Management Fundamentals Sources; composition, generation rates, collection of waste, separation, transfer and transport of waste, treatment and disposal options. Municipal waste management and handling rules for solid waste, hazardous waste, biomedical waste, fly ash, recycled plastics usage and batteries	7
2.	Hazardous and Radioactive Waste Management Fundamentals Characterization of waste, fate and transport of chemicals, health effects, Fundamentals sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options	8
3.	Physiochemical Treatment of Solid waste Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation	7
4.	Biological Treatment of Solid waste and landfill design Biological Treatment of Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor. Landfill design Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration	8
Total		30

Text Books / References:

1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. LaGrega, M.D.Buckingham,P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994.
3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997.
4. Basics of Solid and Hazardous Waste Mgmt. Tech. by KantiL.Shah 1999, Prentice Hall.
5. Solid And Hazardous Waste Management 2007 by S.C.Bhatia Atlantic Publishers & Dist.

Program:	M. Tech. Mechanical (Heat Power Engineering)	Semester:II
Course :	Battery management for Electric Vehicles	Code: MMH2602B

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of Basics of Electrical Engineering Is Essential

Objectives:

1. To understand the various battery performance parameters and types of batteries used for EV applications
2. To understand the requirements of battery management system
3. To make the learners conversant with Equivalent Circuit Cell Modeling of Battery
4. To make the learners conversant with SOC estimation
5. To make the learners conversant with Battery Pack Balancing and Power Estimation
6. To make the learners aware of thermal issues of Lithium Ion battery and thermal management system

Outcomes:

After learning the course, the learners will be able

1. Demonstrate understanding of battery operation parameters and design requirements of battery management systems
2. To simulate charge discharge characteristics of a battery using equivalent circuit model
3. To estimate SOC and SOH of battery and demonstrate understanding of various methods of battery pack balancing
4. To estimate heat generation inside battery and propose cooling strategy for the battery pack.

Detailed Syllabus

Unit	Description	Duration, h
1.	**Introduction to battery-management systems** Battery terminology and performance parameters, Types of electrochemical cells, Lithium-Ion Cells components, primary functions and components of BMS **BMS design requirements** Primary functions of BMS, sensing voltage, current and temperature of cell and battery pack, estimation of cell SOC and battery pack SOC, Estimation of available energy and power of cell and battery pack	7
2.	**Equivalent Circuit Cell Model (ECM)** Modeling OCV and SOC, Modeling voltage polarization, Warburg impedance, Estimation of Model parameter values: OCV, Columbic Efficiency, total capacity, temperature dependence of OCV, modeling hysteresis, using the ECM to simulate constant voltage/ power charge/ discharge characteristics	8
3.	**State-of-Charge (SOC) Estimation and Battery Pack Balancing** Different approaches to estimating battery cell SOC, Kalman-filter method of SOC estimation: linear Kalmanfilter , extended Kalman filter Reasons of battery pack unbalancing, criteria for specifying a balancing set point and when to balance a battery pack ,Passive balancing methods for battery packs, Active balancing methods for battery packs: capacitor-based circuits, transformer-based circuits, Estimation of available battery power using a simplified cell model	7
4.	**Battery Thermal Management** Heat Generation inside battery, Thermal issues of Lithium Ion Battery, Operating temperature range, Energy analysis and Thermal modeling of LIB, Cooling strategies in thermal management : Air cooling, liquid cooling, PCM based cooling , effect of parameters like cell arrangement, spacing, fluid velocity.	8
	Total	30

Reference Books:

1. Gregory L. Plett, Battery Management Systems, Volume I: Battery Modeling, Artech House, London
2. Gregory L. Plett, Battery Management Systems Volume II, Equivalent-Circuit Methods, Artech House, London
3. Gianfranco Pistoia, BoryannLiaw (eds.), Behaviour of Lithium-Ion Batteries in Electric Vehicles_ Battery Health, Performance, Safety, and Cost, Springer International Publication
4. Reiner_Korthauer, Li-I Batteries Basics and Applications, Springer International Publication

Program:	M. Tech. Mechanical (Heat Power Engineering)			Semester: II		
Course:	Renewable Energy Sources			Code: MMH2602C		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of Thermodynamics; Fluid Mechanics; Heat Transfer; Elements of Electrical Engineering Is Essential.

Objectives:

Following concepts to be taught to the students,

1. Demonstrate significance of analysis solar and Wind Resources Sources and design technologies of their utilization
2. Expose them to conceptualize and design renewable energy appliances and equipment
3. Enable them to independently analyze, implement and asses the real-life systems
4. Develop a research insight about renewable technologies so as to motivate all concerned for their enhanced deployment

Course Outcomes:

After learning the course, the learners will be able to

1. Determine the fundamental performance characteristics of solar thermal, photovoltaic and wind energy systems
2. Estimate the potential of solar and wind energy resources
3. Demonstrate understanding of the fundamentals of energy conversion from biomass, geothermal, tidal orwave energy conversion systems
4. Determine the economic feasibility of renewable energy technologies

Detailed Syllabus:

Unit	Description	Duration h
1.	**Solar energy** Potential of Renewable energy sources, Current scenario of worldwide installed capacity, Estimation of solar radiation **Solar thermal collectors** – General description and characteristics of flat plate and concentrating solar collectors, characteristic equation for performance evaluation **Solar Photovoltaic Systems**– Working, Constructional details &performance assessment, Effect of various parameters on output of solar cell, economics	7
2.	**Wind energy** Principles and classification of wind energy conversion systems–Aerodynamics and performance, Site selection considerations, Wind resource / energy potential measurement, wind electric generator components, Operation, maintenance and economics	8
3.	**Energy from biomass -** Sources of biomass, Properties of biomass, Conversion of biomass into fuels – Energy through fermentation – Pyrolysis, gasification and combustion – Aerobic and anaerobic bio-conversion, Biogas plants – Types of plants –operation in dual fuel mode– Properties and Economics	7
4	**Geothermal, Tidal or Wave Energy Conversion** Geothermal energy: hot springs and steam ejection site selection, power plants, and economics. Environmental impacts, Economic and social considerations, Availability, system development and limitations, Wave and tidal energy –Scope and economics, Introduction to integrated energy systems.	8
	Total	30
	Text Books 1. S.P. Sukhatme, Solar Energy – Principles of thermal collection and storage, II edition, Tata McGraw Hill, New Delhi, 1996. 2. Garg H.P., Prakash J., Solar energy Fundamentals and Applications, Tata Mc Graw Hill Publishing Company, New-Delhi, Latest Edition 3. V.V. N. Kishore, Editor, Renewable Energy Engineering and Technology, A knowledge Compendium, The Energy and Resources Institute, New Delhi, 2008	
	Reference Books: **1.** J.A.Duffie and W.A.Beckman, Solar engineering of Thermal processes, II edition, **2.** John Wiley, New York, 1991. **3.** D.Y.Goswami, F.Kreith and J.F.Kreider, Principles of Solar Engineering, Taylor and	

	4. Francis, Philadelphia, 2000. **5.** D.D.Hall and R.P.Grover, Biomass Regenerable Energy, John Wiley, New York,1987. **6.** Mukund R Patel, Wind and Solar Power Systems, CRC Press, 1999. **7.** J F Manwell, J.G.McGowan, A.L.Rogers, Wind Energy Explained: Theory, Design and Application, John Wiley and Sons, May 2002. **8.** R D Begamudre, Energy Conversion Systems, New Age International (P) Ltd., Publishers, New Delhi ,2000. **9.** Bureau of Energy Efficiency – Volume 1

Program:	M. Tech. Mechanical (Design Engineering)				Semester : I	
Course :	Advanced Materials				Code: MMD1601A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of Chemistry, Physics, Material Science, Metallurgy Is Essential.

Objectives:

1. To introduce advanced and exotic materials.
2. To familiarize students with structure and properties of materials.
3. To establish significance of material selection in engineering design.
4. To explore new design opportunities.

Outcomes:

After learning the course, the students should be able to:

1. Student will be able to analyze of different materials in advanced engineering application.
2. Student will be able to relate structure and properties of new materials in engineeringapplications
3. Student will be able to evaluate and select materials for advanced engineeringapplications.

Detailed Syllabus:

Unit	Description	Duration, h
1	Advanced and exotic materials – ceramics and Plastics, Biomaterials, Aerogels, Superconductors, Carbon nano tubes	7
2	Mechanical, electrical, optical and magnetic properties of materials.	8
3	Smart materials, Piezoelectricity, Magnetostriction, smart polymers, Shape memory alloys	7
4	Introduction to nano, Nano- biomimicry, Synthesis of nano materials by physical and chemical methods, Synthesis of nano materials by biological methods, Characterizations of nano materials.	8
	Total	30

Text Books:

1. W.D. Callister Material Science and Engineering: An Introduction, Wileypublication.

Reference Books:

1. Malsch, N.H., “Biomedical Nanotechnology”, CRC Press. (2005).
2. L.F. Pease, R.M. Rose and J. Wulff, Electronic Properties (Volume IV: Structure and Propertiesof Materials)

Program:	**M. Tech. Mechanical (Design Engineering)**				**Semester : I**	
Course :	**Optimization Methods**				**Code: MMD1601B**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE 1**	**IE 2**	**ETE**	**Total**
2	**2**	**2**	**20**	**--**	**30**	**50**

Prior Knowledge of Engineering Mathematics Is Essential.

Objectives:

1. To introduce students to the modeling of constrained decision-making problems and optimization.
2. Provide students with the basic mathematical concepts of optimization.
3. Provide students with the modelling skills necessary to describe and formulate optimization problems.
4. Provide students with the skills necessary to solve and interpret optimization problems in engineering.

Outcomes:

After learning the course, the students should be able to:

1. Formulate mathematical programs in various practical systems
2. Understand basic optimization techniques
3. interpret the results of a model and present the insights (sensitivity, duality)
4. Know the limitations of different solution methodology
5. Use software to solve problems

Detailed Syllabus:

Unit	**Description**	**Duration, h**
1.	**Classical Optimization Techniques** Introduction to Mathematical Modeling, Single variable optimization and multi variable optimization, with constraints and without constraints	**7**
2.	**Linear and non-Linear Programming** Simplex Methods, Elimination and iterative methods for one-dimensional minimization .	**8**
3.	**Simulation Modeling** Introduction, definition and types, limitations, various phases of modeling, Monte Carlo method, applications, advantages and limitations of simulation	**7**
4.	**Modern Methods of Optimization** Genetic algorithms, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization, etc.	**8**
	Total	**30**

Text Books:

1. Engineering Optimization: Theory and Practice, Singiresu S. Rao, John Wiley &Sons
2. Practical Optimization Methods with Mathematical Applications, M. Asghar Bhatti,Springer
3. Optimization for engineering design, K. Deb,PHI

Reference Books:

1. Topology Optimization – Theory, Methods and Applications, M. P. Bendse, Q.Sigmund
2. Evolutionary Topology Optimization of Continuum Structures, Methods and Applications, X.Huang, Y.M. Xie, Wiley
3. Structural Optimization, Raphael T. Haftka and Zafer Gurdal, Kluwer Academic Publishers
4. Mathematical Modelling, J N Kapur, New age international publication
5. Optimization concepts and applications in engineering, Belegundu, Chandrupatla, Pearson Education

Program:	M. Tech. Mechanical (Design Engineering)				Semester : I	
Course :	Modeling and Simulation of Dynamic systems				Code: MMD1601C	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of Engineering Mathematics Is Essential.

Objectives:

1. Students able to model any physical system for real time applications
2. Students able to simulate any physical system for real time applications

Outcomes:

After learning the course, the students should be able to:

1. Develop mathematical model for practical problem
2. Develop Bond Graph model for system
3. Apply transfer function and State space model techniques
4. Simulate the system using suitable software and Estimate parameters by optimization

Detailed Syllabus:

Unit	Description	Duration h
1.	Introduction to Modelling and Simulation, Basic systems, Introduction and Types of Mathematical modelling, Basic building blocks Mechanical, Electrical, Thermal systems.	7
2.	Bond Graph Modelling of Dynamic Systems: Representation, Elements, Single, Two and multiports Causality, Application to basic Mechanical, Electrical and Electro mechanical system	8
3.	Dynamic Response and System Transfer Function: Poles, Stability Block diagram/Signal flow diagram/State Space formulation and Frequency response	7
4.	Simulation and Simulation application Parameter Estimation, System Identification and Optimization	8
	Total	**30**

Reference Books:

1. Brown, Forbes T. Engineering System Dynamics. New York, NY: CRC, 2001. ISBN: 9780824706166.

Program:	M. Tech. Mechanical (Design Engineering)				Semester : II	
Course :	Room Acoustics				Code: MMD2602A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of Engineering Mathematics, Physics Is Essential.

Objectives:

The course includes sound fields in rooms with wave theoretical methods, geometrical acoustics methods Acoustical measurement techniques, sound absorption for evaluation of room acoustic quality

Outcomes:

After learning the course, the students should be able to:

Understand Basic principals in acoustics, measurement of sound Power and apply to analyze effectiveness in compliance to noise regulations.

Detailed Syllabus:

Unit	Description	Duration h
1.	**Basics of acoustics –** Terminologies speed of sound, wavelength, frequency, and wave number, acoustic pressure, acoustic intensity and acoustic energy density, spherical wave, **Acoustic measurement** Directivity factor and directivity index, levels and the decibel, combination of sound sources, octave bands, weighted sound levels. Sound power measurement	7
2.	**Transmission of Sound:** changes in media with normal incidence, changes in media with oblique incidence, sound transmission through a wall, transmission loss for walls - stiffness-controlled region- mass-controlled region - damping-controlled region,	8
3.	**Sound Absorption:** General description of acoustical materials - acoustical tiles, fiberboard, resonator absorption unit absorber, carpets, acoustical plaster, resilient packing composite materials, etc. Their use, selection criteria and construction.	7
4.	**Room acoustics -** surface absorption coefficients, steady-state sound level in a room, Behaviour of sound in an enclosed space. Concept of reverberation and reverberation time effect of energy absorption in the air, noise from an adjacent room, acoustic enclosures, acoustic barriers.	8
	Total	30

Text Books:

Industrial Noise Control, Randell Barron, Marcel Dekker, Inc.

Reference Books:

Mechanical Vibrations & Noise Engineering, A.G.Ambekar, Prentice Hall of India, New-Delhi.

Program:	**M. Tech. Mechanical (Design Engineering)**				**Semester : II**	
Course :	**Design Thinking**				**Code: MMD2602B**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE 1**	**IE 2**	**ETE**	**Total**
2	**2**	**2**	**20**	**--**	**30**	**50**

Prior Knowledge of Any Engineering Graduate Is Essential

Objectives:

1. To acquaint with concepts of Design Thinking.
2. To apply design thinking tools in every field of Engineering.

Outcomes:

After learning the course, the students should be able to:

1. Use Design Thinking tools.
2. Create simple Products using design thinking tools

Detailed Syllabus:

Unit	**Description**	**Duration h**
1.	Introduction to Design thinking and its importance. Steps in Design Thinking	**05**
2.	Empathize Phase	**05**
3.	Define Phase	**05**
4.	Ideate Phase	**05**
5.	Prototype Phase	**05**
6.	Test Phase. One simple Product development using Design thinking tools	**05**
	Total	**30**

Reference Books:

1. Design Thinking methodology book by EmrahYayici, Publisher EmrahYayici,2016
2. Designing for Growth: A design thinking toolkit for managers, Tim Ogilvie ,Columbia Business SchoolPublishing

Program:	M. Tech. Mechanical (Design Engineering)				Semester : II	
Course :	Reliability Engineering				Code: MMD2602C	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of Engineering Mathematics Is Essential.

Objectives:

1. To perform reliability engineering analysis.
2. To compute reliability engineering parameters and estimates for applications in mechanical devices and manufacturing genvironments.

Outcomes:

After learning the course, the students should be able to:

1. Identify the possible faults in systems and their impacts to the overall system reliability.
2. Develop fault trees for a sub-system and apply various reliability models on fault analysis.
3. Evaluate maintenance schedules and assess the corresponding risk with appropriate techniques and tools.

Detailed Syllabus:

Unit	Description	Duration h
1.	**Fundamental concepts - I** Failure density, failure rate, hazard rate, MTTF, MTBF, pdf, cdf, modes of failure, Areas of reliability, Quality and reliability assurance rules, product liability, probability distributions binomial, normal, Poisson.	7
2.	Sy**stem reliability** Series, parallel, mixed configuration, k- out of n structure, complex systems-enumeration method, conditional probability method, cut set and tie set method,	8
3.	**Redundancy** Element redundancy, unit redundancy, standby redundancy- types of stand by redundancy, parallel components single redundancy, multiple redundancy. Markov analysis.	7
4.	**System reliability Analysis** Reliability apportionment, Reliability apportionment techniques – equal apportionment, AGREE, ARINC, feasibility of objectives apportionment.	8
	Total	**30**

Text Books:

1. L.S. Srinath, Concepts of Reliability Engg., Affiliated East-Wast Press (P) Ltd.,1985.
2. E. Balagurusmy, Reliability Engineering, Tata McGraw-Hill Publishing Co. Ltd.,1984.

Reference Books:

1. A.K. Govil, Reliability Engineering, Tata McGraw-Hill Publishing Co. Ltd., 1983.
2. B.S. Dhillion, C. Singh, Engineering Reliability, John Wiley & Sons, 1980.
3. M.L. Shooman, Probabilistic, Reliability, McGraw-Hill Book Co., 1968.
4. P.D.T. Conor, Practical Reliability Engg., John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, Reliability in Engineering Design, John Wiley & Sons, 1977.
6. A. Birolini , Reliability Engineering, Theory and Practice, Third Edition, Springer, 1999

Program:	**M.Tech (Computer Engineering)**				**Semester:**	**I**
Course :	**Programming with Python**				**Code :**	**MCE1601A**
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE 1**	**IE 2**	**ETE**	**Total**
2	**2**	**2**	**20**	**--**	**30**	**50**

Prior Knowledge of Basics of Programming Is Essential.

Objectives:

1. To acquire knowledge in Python and Rprogramming
2. To develop Python programs with conditionals and loops and datastructures
3. Acquire skills to apply data analysis methods to aproblem

Outcomes:

After learning the course the students should be able to:

1. Describe the Numbers, Math functions, Strings, List, Tuples and Dictionaries in Python
2. Interpret Object oriented programming in Python
3. Apply a solution clearly and accurately in a program using Python.

Detailed Syllabus:

Unit	**Description**	**Duration h**
1.	**Introduction to Python Programming:** Python Introduction, Installing and setting Python environment in Windows and Linux, basics of Python interpreter, Execution of python program, Editor for Python code, syntax, variable, Data types. Flow control if if else, for, while, range() function, continue, pass, break. Strings: Sequence operations, StringMethods.	**7**
2.	**Lists:** Basic Operations, List slices,listmethods,list and strings **Dictionaries:** looping and dictionaries, dictionaries & lists. **Tuples and Files :**reading and writing Functions: Definition, Call, Arguments ,Input output file handling.	**8**
3.	**Object Oriented Programming** features in Python: Classes, Objects, Inheritance,Errors and Exceptions: try, except and else statements, Exception Objects, Regular expressions.	**7**
4.	**Numpy and Matplotlib**:Array operations, Numpy Side Effects, 2D Numpy Arrays , Numpy Basic Statistics. Matplotlib: Introduction, Simple plots, Line API, Legend API, Figures, Subplots. **Pandas:** Look Ups, Selections and Indexing, Filling Methods, Series operation, Handling NaN values, Mapping, Data Frames, Reading Files, Plotting, Joins, Correlation, Histograms, Rolling calculation.	**8**
	Total	**30**

Text Books:

1. AllenBDowney,—ThinkPYTHON‖,O'Rielly,ISBN:13:978-93-5023-863-9,4thIndianReprint2015
2. Peng, Roger D and Elizabeth Matsui, —The Art of Data Science." A Guide for Anyone Who Works with Data. Skybrude Consulting 200 (2015):162

Reference Books:

1. Zed A. Shaw,Learn Python the Hard Way

Program:	M.Tech (Computer Engineering)				Semester : I	
Course :	Software Engineering Basics				Code : MCE1601B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Objectives:

1. To learn and understand the principles of Software Engineering
2. To be acquainted with methods of capturing, specifying, visualizing and analyzing software requirements.
3. To apply Design and Testing principles to S/W project development.
4. To understand project management through life cycle of theproject.
5. To understand software quality attributes.

Outcomes:

After learning the course the students should be able to:

1. Decide on a process model for a developing a software project
2. Classify software applications and Identify unique features of various domains
3. Design test cases of a software system.
4. Understand basics of IT Project management.
5. Plan, schedule and execute a project considering the risk management.
6. Apply quality attributes in software development lifecycle.

Detailed Syllabus:

Unit	Description	Duration h
1.	**Introduction to Software Engineering and Software Process Models:** Software Engineering Fundamentals: Nature of Software, Software Engineering Principles, The Software Process, Software Myths. Process Models :A Generic Process Model, Prescriptive Process Models: The Waterfall, Incremental Process(RAD), Evolutionary Process, Unified Process, Concurrent. Advanced Process Models & Tools: Agile software development: Agile methods, Plan-driven and agile development.	7
2.	**Software Requirements Engineering and Analysis:** Requirements Engineering: User and system requirements, Functional and non-functional requirements, Types & Metrics, A spiral view of the requirements engineering process. Software Requirements Specification (SRS): The software requirements Specification document,ThestructureofSRS,WaysofwritingaSRS,Requirementselicitation& Analysis: Process, Requirements validation, Requirements management.	8
3.	**Design Engineering:** Design Process & quality, Design Concepts, The design Model, Pattern-based Software Design. Architectural Design :Design Decisions, Views, Patterns, Application Architectures, Modeling Component level Design: component, Designing class based components, conducting component-level design, User Interface Design: The golden rules, Interface Design steps & Analysis, Design Evaluation	7
4.	**Project Risk Management:** Risk Analysis & Management: Reactive versus Proactive Risk Strategies, Software Risks, Risk Identification, Risk Projection, Risk Refinement, Risk Mitigation, Risks Monitoring and Management, The RMMM plan for case study project	8
	Total	30

Text Books:

1. Roger Pressman, ―Software Engineering: A Practitioner ‘s Approach‖, McGraw Hill, ISBN 0–07–337597
2. Ian Sommerville, ― Software Engineering‖, Addison and Wesley, ISBN 0-13-703515-2

Reference Books:

1. Carlo Ghezzi, ―Fundamentals of Software Engineering", Prentice Hall India, ISBN-10: 0133056996
2. RajibMall,―FundamentalsofSoftwareEngineering‖,PrenticeHallIndia,ISBN-13:978-8120348981
3. PankajJalote,―AnIntegratedApproachtoSoftwareEngineering‖,Springer,ISBN13:9788173192715.

4. SKChang,―HandbookofSoftwareEngineeringandKnowledgeEngineering‖,WorldScientific,VolI,II, ISBN:978-981-02-4973-1
5. TomHalt,―HandbookofSoftwareEngineering‖,ClanyeInternational,ISBN10:1632402939
6. Christine Bresnahan, Richard Blum –Linux command line and Shell Scripting Bible -Weilly , ISBN-978-0- 470-25128-7

Program:	M.Tech (Computer Engineering)			Semester :	I	
Course :	Basics of Machine Learning			Code:	MCE1601C	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of

1. Linear Algebra, Statistics, Probability and Calculus
2. Basic Programming Skills

Is Essential

Objectives:

1. To master the concepts of supervised and unsupervised learning, recommendation engine, and time series modeling
2. To gain practical knowledge over principles, algorithms, and applications of Machine Learning through a hands-on approach and to validate Machine Learning models and decode various accuracy metrics. Improve the final models using another set of optimization algorithms, which include Boosting & Bagging techniques
3. To acquire thorough knowledge of the statistical and heuristic aspects of Machine Learning and To comprehend the theoretical concepts and how they relate to the practical aspects of Machine Learning.
4. 4.Toimplementmodelssuchassupportvectormachines,kernelSVM,naiveBayes,decisiontree classifier, random forest classifier, logistic regression, K-means clustering

Outcomes:

After learning the course the students should be able to:

1. Understand machine learning techniques and computing environment that are suitable for the applications under consideration.
2. Solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
3. Develop scaling up machine learning techniques and associated computing techniques and technologies for various applications.
4. Implement various ways of selecting suitable model parameters for different machine learning techniques.

Detailed Syllabus:

Unit	Description	Duration h
1.	**Foundations for Machine Learning [ML]:** ML Techniques overview: Supervised; Unsupervised, Reinforcement Learning,Validation Techniques (Cross-Validations)**;**Feature Reduction/Dimensionality reduction;Principal components analysis (Eigen values, Eigen vectors, Orthogonality)	7
2.	**Clustering:** Distance measures;Different clustering methods (Distance, Density, Hierarchical); Iterative distance-based clustering; Dealing with continuous, categorical values in K-Means; Constructing a hierarchical cluster; K-Medoids, k-Mode and density-based clustering; Measures of quality of clustering	8
3.	**Classification: Naïve Bayes Classifier** Model Assumptions; Probability estimation; Required data processing; M-estimates;, Feature selection: Mutual information; Classifier **K-Nearest Neighbors:** K-Nearest Neighbor algorithm; Aspects to consider while designing K-Nearest Neighbor Support Vector Machines ;SVM for classification and regression problems.	7
4.	**Association Rule mining:** The applications of Association Rule Mining: Market Basket, Recommendation Engines, etc. ; A mathematical model for association analysis; Large item sets; Association Rules; Apriori: Constructs large item sets with mini sup by iterations; Interestingness of discovered association rules; Application examples; Association analysis vs. classification ; FP-trees	8

	Research Aspects: Application of ML in various domains-Research Paper Publication in Quality Indexed International Journals/ Conferences; Practical Implementation of Industry Projects/Applications**;** IPR	
	Total	**30**

Text Books:

1. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e,2008.
2. Christopher Bishop. Pattern Recognition and Machine Learning. 2e.

Reference Books:

1. Ethem Alpaydin, Introduction to Machine Learning

Program:	M.Tech (Computer Engineering)			Semester : II		
Course :	Image Processing with MATLAB			Code: MCE2602A		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of Programming Basics Is Essential

Objectives:

1. Develop an overview of the field of image processing.
2. Cover the basic theory and algorithms that are widely used in digital image processing.
3. Develop hands-on experience in using computers to process images.
4. Familiarize with MATLAB Image Processing Toolbox Course

Outcomes:

After learning the course, the students should be able to:

1: Understand the need for image transforms different types of image transforms and their properties.

2: Learn different techniques employed for the enhancement of images.

3: Understand the need for image compression and to learn the spatial and frequency domain techniques of image compression.

4: Learn different feature extraction techniques for image analysis and recognition.

5: Develop any image processing application.

Detailed Syllabus:

Unit	Description	Duration h
2.	**Introduction:** What is image processing?, What are the fundamental issues? , What is the role of perception? Image sampling and quantization, Basic relationship between pixels, MATLAB orientations. **Image Transformations:** Discrete Fourier transform, Properties of 2D DFT, FFT, Convolution, Correlation, Discrete cosine transform, Discrete Wavelet transform.	7
2.	**Image Enhancement Techniques** Spatial Domain Techniques: Basic gray level transformations, Histogram processing, Image subtraction, Image averaging, Spatial filtering, Smoothing filters, Sharpening filters. Frequency Domain Techniques: Frequency domain filtering, Image smoothing and Image sharpening using frequency domain filters.	8
3.	**Color image processing:** Color fundamentals, Color models, Color transformation, Smoothing and Sharpening **Image Compression:** Fundamentals, Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Huffman coding, Arithmetic coding, Golomb coding, LZW coding, Block transform coding, Run-length coding, JPEG Lossless predictive coding, Lossy predictive coding, Wavelet coding.	7
4.	**Morphological Image processing:** Basics, Erosion, Dilation, Opening, Closing, Hit-or-Miss transform, Boundary Detection, Hole filling, Connected components, Convex hull, Thinning, Thickening, Skeletons, Pruning. **Image Segmentation and Representation:** Point, Line and Edge detection, Edge linking and Boundary detection, Thresholding, Basic global tresholding, Otsu's method, Region based segmentation, Use of motion in segmentation	8
	Total	30

Text Books:

1. R. C.Gonzalez, R.E.Woods," Digital Image processing", Pearson edition,Inc3/e,2008.
2. A.K.Jain," Fundamentals of Digital Image Processing",PHI,1995

Reference Books:

7. J.C. Russ," The Image Processing Handbook", (5/e), CRC, 2006
8. R.C.Gonzalez& R.E. Woods; "Digital Image Processing with MATLAB", Prentice Hall, 2003
9. W. K. Pratt, Digital Image Processing, John Wiley & Sons, 2006.
10. S. Ahmed, Image Processing, McGraw -Hill, 1994.
11. S. J. Solari, Digital Video and Audio Compression, McGraw-Hill, 1997

Program:	**M.Tech (Computer Engineering)**				**Semester :**	**II**
Course :	**Linux Essentials**				**Code:**	**MCE2602B**
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE 1**	**IE 2**	**ETE**	**Total**
2	2	2	20	--	30	50

Objectives:

1.To acquire knowledge of basic Linux OS, commands, and terminologies

2.To develop programs using Shell scripting

3. To acquire skills related to Linux file system

Outcomes:

After learning the course the students should be able to:

1. Use common and simple Linux commands
2. Demonstrate programming ability using Unix Shell
3. Develop collaboratively using GIT and write research-papers using LaTex
4. Apply a solution clearly and accurately in Linux environment

Detailed Syllabus:

Unit	**Description**	**Duration h**
1	**Introduction to Linux:** Linux introduction; Understanding philosophy of Linux; Understanding Software Licensing and Linux Distributions; Architecture of Linux OS; Installation of Linux OS (direct and using virtual machine); Using common Linux programs: Linux desktop environment, working with different productivity software; Understanding and managing hardware: CPU, Disk issues, Device drivers, Displayetc.;	**7**
2.	**Basic Commands and Shell Scripting:** Introduction to Linux commands, concept of shell, shell variables, getcwd () and pwd; Introduction to shell programming features: Variables declaration &scope, test, return value of a program, if-else and useful examples, for and while loop, switch case; Shell functions, pipe and redirection, wildcards, escape characters; Awk script: Environment and workflow, syntax, variables, operators, regular expressions, arrays, control flows, loops, functions, output redirections	**8**
3.	**Linux File System and Networking:** File System - Manipulating Files: creating, deleting, copying, moving, renamingetc; Using absolute and relative path; Manipulating Directories: Creating, Deleting and Managing; Basic File and Directory commands; Understanding Linux file system; Networking - Understanding network features; Configuring a network connection; Testing a network connection;	**7**
4.	**Essential System Administration** **Users and Group Management:** Users and Group management: Creation, Updating, Deletion of user and group; Commands –shadow, useradd, usermod, userdel, groupadd, groupmod, group deletc; Managing ownership and permission. **Process and Package Management:** Understanding package management,package management commands like rpm, yum, apt; Understanding Process hierarchy and identifying running processes; Logfiles. **Or** **Introduction to GIT and LaTEX:** LaTEX: Basic syntax, compiling and creating documents; Document structure including sections and paragraphs; Adding Images, Table of contents, Source code, graphs; Adding references, and Bibliography; Installation and Hands-on of LaTEX. GIT: Creating a project using GIT locally, add, commit; Branch and Merge; Cloning a remote repo, working with a remote repo; Working on a project in a distributed fashion; Hands-on of GIT.	**8**
	Total	**30**

Text Books: 1. Christine Bresnahan, Richard Blum ―Linux Essentials, Sybex, ISBN9781119092063 2. Sumitava Das, Unix Concepts and Applications, Tata-McGraw Hill, ISBN0-07-063546-3
Reference Books: 1.Christine Bresnahan, Richard Blum –Linux command line and Shell Scripting Bible -Weilly , ISBN-978-0-470-25128-7

Program:	M.Tech (Computer Engineering)				Semester : II	
Course :	Design with UML				Code : MCE2602C	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of :.Basic understanding of computer programming and related programming paradigms Is Essential.

Objectives:

1. To introduce the concept of Object-oriented design
2. To understand and differentiate Unified Process from other approaches
3. To design static and dynamic UML diagrams

Outcomes:

After learning the course the students should be able to:

1. Understand Basic features and elements of the object-oriented approach
2. Identify, analyze, and model structural and behavioral concepts of the system.
3. Apply the concepts of architectural design for deploying the code for software.

Detailed Syllabus:

Unit	Description	Duration h
1.	Introduction to UML: Importance of modeling, principles of modeling, object-oriented modeling, conceptual model of the UML, Architecture, Software Development Life Cycle	6
2.	Basic Structural Modeling: Classes, Relationships, common Mechanisms, and diagrams. Advanced Structural Modeling: Advanced classes, advanced relationships, Interfaces, Types and Roles, Packages. Class & Object Diagrams	6
3.	Basic and Advanced Behavioral Modeling: Interactions, Interaction diagrams. Use cases, Use case Diagrams, Activity Diagrams. Advanced Behavioral Modeling Events and signals, state machines, processes and Threads, time and space, state chart diagrams.	6
4.	Architectural Modeling: Component, Deployment, Component diagrams and Deployment diagrams. Common modeling techniques	6
	Total	24

Text Books:

1. Grady Booch, - The unified modeling language user guide. Pearson Education India, ISBN:0-201-57168
2. James Rumbaugh. MichealBlaha- Object-Oriented Modeling and Design with UML: PearsonEducation India, ISBN-13:978-0130159205

Reference Books:

2. Charles Ritcher - Designing Flexible Object-Oriented systems with UML. New RidersPublishing.
3. Jackson, Burd Thomson - Object Oriented Analysis & Design. Thomson CourseTechnology.
4. Mike O'Docherty - Object-Oriented Analysis and Design: using UML. WileyPublication
5. Joseph Schmuilers - Teach Yourself UML in 24 Hours. Samspublishing.

Program:	M. Tech. (Civil) Construction Management				Semester:	I
Course :	Project Management and Finance				Code :	MCI1601A
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of : Basics of Management, Basics of Finance Is Essential.

Objectives:

1. To demonstrate knowledge and understanding of engineering and management principles.
2. To function effectively as an individual, and as a member or leader in diver seteams.
4. To understand the concepts of finance and accounts carried out in project management.

Outcomes:

After learning the course, the students should be able to:

1. Study the current market trends and choose projects.
2. Prepare project feasibility reports.
3. Ability to implement the project effectively meeting government norms and conditions.
4. Ability to understand the role and responsibility of the Professional Engineer.
5. Ability to choose projects which benefit the society and organization.

Detailed Syllabus:

Unit	Description	Duration h
1	**Introduction to Management** What is Management? It's Need ,Importance& Purpose, Evolution of Managements thought, Different Schools/ approaches to Management: Behavioral, Quantitative, Systems, Contingency Approach	7
2.	**Project Implementation, Monitoring and Control** Project representation: Role of project managers, relevance with objective of organization, preliminary manipulations, Basic Scheduling concepts: Resource levelling, Resource allocation, Setting a base line, Project management information system: Importance of contracts in projects: Team work in Project Management: Formation of Effective terms.	8
3.	**Organizing** Organizing as a Management process, Principles of Organization, Different Structures of organizations such as line, Line & Staff, Functional, Matrix or project Organization: Characteristics, Features, their Merits and Limitation, Ownerships of Organization: Sole Proprietorship, Partnership, Private Ltd., Public Ltd., Introduction to Organizational climate, Decision Making, Group Decision Making, Staffing: What is Staffing? Steps involved in Staffing, Recruitment, Staffing, Performance Appraisal Development	7
4.	**Financial Statements and Their Analysis** Understanding of Financial Statements and Their Analysis, Like Balance Sheet, Profit &Loss Account ,Ratio Analysis, Fund Flow Analysis, Statement of Changes In Financial Position.	8
	Total	30

Text Books:

1. Project Management Institute A Guide to the Project Management Bodyof Knowledge PMBOK Guide (Sixth Edition), Sept2017.
2. James C.Van Horne, Fundamentals of Financial Management, Person Education2004.
3. Khanna, R.B.,Project Management, PHI2011.

Reference Books:

1. Kuster J., Huber, E., Lippmann, R., Schmid, A., Schneider, E., Witschi, U., Wust, R. Project Management Handbook,2015.
2. Prasanna Chandra, Financial Management, Tata McGraw-Hill, 2008.
3. Carl S. Warren, James M. Reeve, JonathanDuchac.
4. Financial and Managerial Accounting,2016
5. Paneer Selvam, R., and Senthilkumar, P., Project Management, PHI,2011.

Program:	M. Tech. (Civil) Construction Management				Semester: I	
Course :	Green Technology				Code:	MCI1601B
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of Environmental study, Types of pollution Is Essential.

Objectives:

After Completing this course, student will have adequate background to understand and solve the problem involving:

1. To learn about Global warming and its effect
2. To demonstrate knowledge in the reduction of global warming.
3. To learn the control measures of carbon emission and accumulation.
4. To learn high tech measures for Reducing Carbon Emissions.

Outcomes:

After learning the course, the students should be able to:

1. Study the effects of Global warming
2. Implement the concept of reduction of global warming
3. Understand the remedial action for the carbon emission and accumulation.
4. Apply high tech measures for Reducing Carbon Emissions.

Detailed Syllabus:

Unit	Description	Duration h
1.	**Global Warming and its effect:-**Introduction and physical definition of global warming, the New Carbon Problem: Accumulation, Long Half-Life, Heating Potential, Carbon Emission Factors, Carbon Absorption in Nature, The Global Emission Situation and its effect in India, The Kyoto and Other Protocols and its view in India, Effect of climate change and its impact. **Planning for the Future to reduce global warming:-**Steps taken to Control Carbon Emissions universally, Use of Promotional and Punitive Mechanisms for Reducing Carbon in Atmosphere, The General Approach in Planning for the Future, Developing Countrywide Adaptive Measures for Safety of Local People, Developing Mitigative Measures for Global Reduction of Carbon, India's National Action Plan on Climate Change (NAPCC) till date, National Mission for a Green India, The MRV Debate.	7
2.	**Opportunities in Control of Carbon Emissions and Accumulation:-** Essential Steps for Control of Carbon Emissions and Accumulation, Procedure to develop own Priorities and Business Opportunities in India for control of carbon emissions and accumulation, Needs a Mix of Green and Traditional Power Sources in India, A Logical Approach for Carbon Reduction, Need in India —More Forests, Less Deforestation and payment rates procedure for controlling carbon emissions and its Promotional Mechanisms at India**.** **Green Technologies for Energy Production:-** Various Technologies Available for Energy Production, Cost Comparison of a Few Typical Systems for Power Generation, Sources of Energy Production Already in Use, Alternative Methods Ready for Use, Green Technologies Needing some Prior R&D Work.	8
3.	**Green Technologies for Personal and Citywide Application :-** Measures to be taken for Green city, Carbon Emission Reduction at Personal Level, Carbon Emission Reduction at Local Authority and Citywide Level, Carbon Emissions from Imports. **Green Technologies for Specific Applications:-**Promotion of 'Green' Buildings, Guidelines, The Energy Conservation Building Code (ECBC), Green Hotels and Hospitals, Green Technologies for Transport, Green Roads, Ports and Harbors, Industries, Carbon, Carbon Emissions from a Few Selected Industries in India, The Changing Scenario in Cities, Need for Wider Application to Town Planning and Area Re-Development Projects ,'Green' Infrastructure for Municipal Services, Bringing up Indian Villages, Green Services for Crematoria, Spreading Message to all Stakeholders.	7

4.	**Some High-tech Measures for Reducing Carbon Emissions :-** Use of Solar Power with Satellite-Based Systems ,Use of Carbon Capture and Storage (Sequestration) ,Microorganisms, A Quick SWOT Analysis. **Recommended Plan of Action :-** India's National Action Plan Take Us to a Low-Carbon Path, The Missions Help Develop Awareness, Few case studies on Projects undertaken by Various Countries, Adaptive Measures Essential for Indian People to Cope with Climate Change	**8**
	Total	**30**
Text Books: 1. Green Technologies, Soli J. Arceivala, Mc Graw Hill Education.		
Reference Books 1. Green Technologies and Environmental Sustainability edited by Ritu Singh, SanjeevKumar 2. http://cpcbenvis.nic.in/greentechnology.html		

Program: M. Tech. (Civil) Construction Management					**Semester: I**	
Course: Organisation Behaviour (OE I)					**Code: MCI1601C**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Credit**	**Hours**	**IE -1**	**IE-2**	**ETE**	**Total**
2	2	2	**2**	-	30	50

Pre- requisite: Knowledge of different types of Organisations structures.

Course Objective: To introduce the students with various features of Microsoft Project.

Course Outcomes: At the end of the course, students will be able to understand

1. Understand important and organisation culture of OB for organisation.
2. Apply different learning theories of learning to organisation.
3. Appraise group behaviour, leadership skills, power and politics in organisation.
4. Relate to organisation culture, climate and work stress.

Detailed Syllabus:

Unit	**Description**	**Duration H**
1	**Introduction to OB**: Disciplines contributing to OB, Need and Importance of OB, Challenges and Opportunity for OB, OB model, Approaches to Organizational Behaviour, Inherited characteristics, Learning, theories of learning, reinforcement.	**7**
2	**Motivation and behavior in group and team work**: Motivation at work; theories of motivations, motivation from concept to applications, Designing motivating jobs, Group Decision Making, Differences Between Groups and Teams, Types of Teams, Creating Effective Teams	**8**
3.	**Leadership, Power and Politics:** Trait Theories, behavioural Theories, Contingency Theories, Authentic Leadership: Ethics and Trust, A Definition of Power, Bases of Power, Power Tactics, Causes and Consequences of Political behaviour	**7**
4	**Organization culture, climate and stress management:** signifance of culture in organization, creating sustainable cultures, Creating a Positive Organizational Culture, Creating a Culture for Change, Work Stress and Its Management, Case studies of OD intervention sin mega-construction projects.	**8**
	Total	**30**

Reference Books:

- Gregery Moorhead, Ricky W. Griffin, Organizational Behaviour: Managing People and Organizations, 3rd Edition, Houghton Miffin Company, 2000
- Stephen, P Robbins, Organizational Behaviour, 9th edition, Pearson Education Asia, New Delhi, 2001
- Wendell L French, Cecil H. Bell, Jr., Organization Development: Behavioural Science Interventions for Organization Improvement, 6th edition, Pearson Education Asia, New Delhi, 2001.
- Jit. S. Chander, Organizational Behaviour, 3rd edition, Vikas Publishing House Pvt. Ltd.,, New Delhi, 2005.

Program:	M. Tech. (Construction Management)				Semester: II	
Course :	Contracts, Tendering & Arbitration				Code:	MCI2602A
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Objectives:

1. To equipped with knowledge of contracts system.
2. To study principles and specifications for making tender documents
3. To learn basic principles of Arbitration in the context of various construction aspects.

Outcomes:

After learning the course, the students should be able to:

3. Adopting the ethical knowledge for making construction contracts &Tenders.
4. Prepare Tendering documents as per conditions of contract.
5. Exhibit concept of Arbitration to resolution of disputes in construction projects.

Detailed Syllabus:

Unit	Description	Duration h
1.	**Construction Contracts:** Indian Contract Act (1872): Definition of the contract as per the ACT. Valid, Voidable, Void contracts, Objectives of the act. Introduction: To law, Indian legal system, Laws governing structure & Working of Construction Organization Firms, Laws of Tort.	7
2.	**Construction Contract Documents:** Evaluation of contract documents, need for documents, present stage of national and international contract documents, types of construction contracts, roles and functions of parties to the contract. Contract Formation.	8
3.	**Stages in Contracting:** Preparation of tender documents estimating, pre - qualification, bid evaluation, award of contract, project financing and contract payments, contracts close out and completion.	7
4.	**Arbitration:** Comparison of Actions and Laws - Agreements, subject matter-Violations- Appointment of Arbitrators-Conditions of Arbitrations-Powers and duties of	8
	Total	30

Text Books:

1. Civil Engineering Contracts and Estimates - B.S.Patil – Universities Press- 2006 Edition ,reprinted in2009.
2. The Indian Contract Act (9 of 1872), 1872- Bare Act- 2006 edition, Professional Book Publishers.
3. The Arbitration and Conciliation Act,(1996), 1996 (26 of 1996)- 2006 Edition, Professional Book Publisher.

Reference Books:

1. Law of contract Part I and Part II, Dr. R.K. Bangia- 2005 Edition, Allahabad Law Agency.
2. Arbitration, Conciliation and Alternative Dispute Resolution Systems- Dr. S.R. Myneni- 2004 Edition, reprinted in 2005- Asia Law House Publishers.
3. The Workmen‘s Compensation Act, 1923 (8 of 1923) Bare Act- 2005-Professional Book Publishers.
4. Standard General Conditions for Domestic Contracts- 2001 Ministry Of Statistics and Program Implementation, Government of India.
5. FIDIC Document(1999).
6. Dispute Resolution Board foundation manual-www.drbf.org. 30Edition

Program:	M. Tech. (Civil) Construction Management				Semester:	II
Course :	Total Quality Management in Construction				Code:	MCI2602B
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of TQM& MIS at UG Level , Awareness of Quality Construction Aspects Is Essential.

Objectives:

1. To **understand** the need of QM in construction and **apply** necessary tools toachieve
2. To **apply** necessary trainings for the effective utilization of resources
3. To **apply** effectively the eight principles of ISO for quality processes in construction
4. To **apply** Six Sigma tool for TQM in construction project

Outcomes:

After learning the course, the engineers should be able to:

1. Understand and apply the TQM phylosophy inc onstruction
2. Able to use effectively QC tools.
3. Apply ISO principles for effective Quality processes in construction
4. Able to apply Six Sigma effectively.

Detailed Syllabus:

Unit	Description	Duration h
1.	**Concepts of Quality** A) Definition of quality as given by Deming, Juran, Crosby, difference between Quality control, Quality Assurance (QA/QC). Total quality control (TQC) and Total Quality Management (TQM), Need for TQM in construction industry. Organization necessary for implementation of quality, Quality manual-Contents, data required, preparation, responsibility matrix, monitoring for quality- PDCA Cycle. Quality aspects in every phase in the life cycle of Construction project.	**7**
2.	**Quality Control Tools** Histogram, Pareto diagram, Fish-bone diagram, Quality control chart-Testing required for quality control of construction material used in RCC Work- destructive and Non destructive Test (NDT). Statistical Quality Control-Necessity, Benchmarking.	**8**
3.	**Study of ISO 9004- Quality System Standards.** Purpose of ISO Standards. Difference between ISO 9001 and ISO 9004. Certification process for ISO 9001. Certification bodies involved. Eight Principles of ISO-Basic meaning, applying these principles for an effective quality process in the organization. Management support and commitment necessary for achieving implementation for quality system standards. **Development** of quality circles, quality inspection team, inspection reports, monitoring and control, 360‘ feedback for quality.	**7**
4.	**A) SixSigma** Definition of six sigma, evolution – Historical aspects, probability distribution Six sigma ratings, Six sigma training, six sigma as an effective tool in TQM. **B) Application of SixSigma** i) RCC Work inbuilding (ii) Assessment of overall construction process from concept to completion of a construction project.	**8**
	Total	**30**

Text Books:

1. Quality Control and Total Quality Management by P.L.Jain- Tata McGraw Hill Publ.Company Ltd
2.Total Engineering Quality Management – Sunil Sharma – Macmillan India Ltd.
3.Total Project Management – The Indian Context - P.K.Joy Macmillan India Ltd.

Reference Books:

1. International Standards Organization – ISO 9001 and ISO 9004
2. Mantri Handbook – A to Z of Construction – MantriPublications
3. Juran‘s Quality Handbook – Joseph M. Juran, A. Blanton. Godfrey – Mcgraw Hill International Edition(1998)
4. Management Information Systems – Gordon B. Davis, Margrethe H. Olson – Tata McGraw Hill Publ.Co.

Program:	**M. Tech. Civil (Construction Management)**			**Semester :**	**II**	
Course :	**Operation Research**			**Code : MCI2602C**		
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	2	20	--	30	50

Pre-requisite: Statistical Mathematics

Objectives:

Outcomes: After learning the course, the engineers should be able to:

Acquire a sound knowledge of principles of Operation Research and its applications.

Apply forecasting methods / principles of scheduling, sequencing, maintenance planning for OR.

Select and apply appropriate methods / techniques in Civil Engineering management situations for project planning / management and finance through critical thinking.

Detailed Syllabus:

Unit	**Description**	**Duration h**
	Use of Operations Research in Engineering and Managerial Decision making process. Introduction to Optimization Techniques and their application in Engineering Planning, Design and Construction. Various models; Objective function and constraints.	**7**
	Linear programming: Formulation of Linear optimization models, Civil engineering applications. Simplex method, special cases in simplex method, Method of Big M, Two phase method, duality, sensitivity analysis.	**8**
	a) Transportation Model and its variants, b) Assignment Model and its variants. c) Decision theory.	**7**
	(a) Queuing Theory, Simulation. (b) Sequencing model – n jobs through 2, 3 and M machines. (c) Replacement models. (d) Games Theory.	**8**
	Total	**30**

Text Books:

1. Operations Research by Hamdy A.Taha
2. Engineering Optimazation Theory & Practice – S.S. Rao., Wiely.
3 .Engineering Optimization—Methods and Applications—Ravindran,Wiely
4. Operations Research by J.K.Sharma
5. Quantitative Techniques in Management by N.D.Vohra

Reference Books:

1. Principles of Construction Management by R.Pilcher
2. Operations Management by E.S.Buffa
3. Principles of Operations Management by H.M.Wangner
4. Principles of Operation Research – Wagner, Prentice Hall.
5. Operation Research – Hira and Gupta, S.Chand
6. Operations Research: Principles and Practice-Ravindrav,Philip&Solberg,Wiley,India

Program:	**M. Tech. (Artificial Intelligence and Data Science)**				**Semester : I**	
Course :	**R Programming**				**Code :MDS1601A**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	**2**	**2**	**20**	**-**	**30**	**50**

Pre-requisite:

1. Knowledge of Statistics in Mathematics
2. Prior Knowledge of any programming

Objectives:

1. To use R and R Studio Environment
2. To understand different data types and control structures in R
3. To interface R with other languages.
4. To understand the use of R for Big Data analytics.

Outcomes:

After learning the course, the students should be able to:

1. Explain the basics in R programming in terms of constructs, control statements, string functions.
2. Apply the use of R for Big Data analytics.
3. Learn to apply R programming for Text processing.
4. Able to appreciate and apply the R programming from a statistical perspective.

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs.)**
1.	**Getting Started with R Programming** Introduction to the R-Studio, user-interface, Basic commands, Data Structures in R, Reading data into R Subsetting	**7**
2.	**Matrices, Arrays And Lists** Creating matrices ,Matrix operations ,Applying Functions to Matrix Rows and Columns, Adding and deleting rows and columns, Vector/Matrix Distinction, Avoiding Dimension Reduction, Higher Dimensional arrays, Lists, Creating lists, General list operations,– Accessing list components and values, Applying functions to lists, Recursive lists	**8**
3.	**Data Frames** Creating Data Frames, Matrix-like operations in frames, Merging Data Frames, Applying functions to Data frames, Factors and Tables: factors and levels, Common functions used with factors, Working with tables, Other factors and table related functions, Control statements: Arithmetic and Boolean operators and values, Default values for arguments, Returning Boolean values, Environment and Scope issues: Writing Upstairs - Recursion ,Replacement functions, Tools for composing function code, Math and Simulations in R	**8**
4.	**Interfacing** Interfacing R to other languages, Parallel R, Basic Statistics, Linear Model, Generalized Linear models, Non-linear models, Time Series and Auto-correlation – Clustering	**7**
	Total	**30**

Text Books:

1. Mark Gardener, " Beginning R – The Statistical Programming Language", Wiley,2013
2. Norman Matloff , "The Art of R Programming: A Tour of Statistical Software Design", No Starch Press,2011

Reference Books:

1. Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison-Wesley Data & Analytics Series, 2013
2. Robert Knell, "Introductory R: A Beginner's Guide to Data Visualization, Statistical Analysis and Programming in R", Amazon Digital South Asia Services Inc,2013.

Program:	M. Tech. (Artificial Intelligence and Data Science)			Semester :	I	
Course :	Business Analytics			Code :	MDS1601B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Pre-requisite: 1. Machine Learning
2. Data Science

Objectives:

1. Understand the different basic concept / fundamentals of business statistics
2. Understand the concept of Probability and its usage in various business applications.
3. Understand the practical application of Descriptive and Inferential Statistics concepts and their uses for Business Analytics.
4. Evaluate different data analytics tools.

Outcomes:

After learning the course, the students should be able to:

1. Gaining Knowledge of basic concept / fundamentals of business analytics.
2. Evaluating basic concepts of probability and perform probability theoretical distributions.
3. To perform practical application by taking managerial decision and evaluating the Concept of Business Analytics.
4. Evaluate different tools.

Detailed Syllabus:

Unit	Description	Duration (Hrs.)
1.	**Introduction** What is business analytics?, Business Analytics process: problem framing, Data modeling, model building, Deployment, Different types of business analytics, application of business analytics, current trends, roles within data analytics team.	**8**
2.	**Analytics Techniques** Optimization techniques: Linear Programming, Goal Programming, Integer Programming, Non –linear programming, Predictive modelling :- regression, multiple linear regression for predictive analysis, logistic regression, linear discriminate analysis, Data Mining: Introduction to supervised and unsupervised learning, clustering	**8**
3.	**Probability Theory & Distribution** Probability: Theory of Probability, Addition and Multiplication Law, Baye's Theorem Probability Theoretical Distributions: Concept and application of Binomial; Poisson and Normal distributions. Concept of Business Analytics- Meaning types and application of Business Analytics, Use of Spread Sheet to analyze data-Descriptive analytics and Predictive analytics	**8**
4.	**Data analytics tools** Data Visualization using Tableau/Python/R/SQL. Case study.	**6**
	Total	**30**

Text Books:

- R.N. Prasad , Seema Acharya, "Fundamentals of business analytics", Wiley

Reference Books:

1. James Evans, Business Analytics, 2nd Edition, Pearson

Program:	M. Tech. (Artificial Intelligence and Data Science)	Semester :	II
Course :	Python for Data Science	Code :	MDS2602A

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Pre-requisite: 1. Python basics ; 2.Statistical and numerical methods

Objectives:

1. Apply various Python data structures to effectively manage various types of data.
2. Explore various steps of data science pipeline with role of Python
3. Design applications applying various operations for data cleansing and transformation.
4. Use various data visualization tools for effective interpretations and insights of data.

Outcomes:

After learning the course, the students should be able to:

1. Gain an in-depth understanding of data science processes and the basics of statistics.
2. Explain the essential concepts of Python programming.
3. Perform high-level mathematical computations.
4. Perform data analysis and manipulation.

Detailed Syllabus:

Unit	Description	Duration (Hrs.)
1.	**Overview of Python and Data Structures** Basics of Python including data types, variables, expressions, objects and functions. Python data structures including String, Array, List, Tuple, Set, Dictionary and operations them	**6**
2.	**Data Science and Python** Discovering the match between data science and python: Outlining the core competencies of a data scientist, Linking data science, big data, and AI , Understanding the role of programming, Creating the Data Science Pipeline, Preparing the data, Performing exploratory data analysis, Learning from data, Visualizing, Obtaining insights and data products, Understanding Python's Role in Data Science Introducing Python's Capabilities and Wonders: Why Python?, Grasping Python's Core Philosophy, Contributing to data science, Discovering present and future development goals, Working with Python, Getting a taste of the language, Understanding the need for indentation, Working at the command line or in the IDE, Performing Rapid Prototyping and Experimentation, Considering Speed of Execution, Visualizing Power, Using the Python Ecosystem for Data Science, Accessing scientific tools using SciPy, Performing fundamental scientific computing using NumPy, Performing data analysis using pandas, Implementing machine learning using Scikit-learn, Going for deep learning with Keras and TensorFlow, Plotting the data using matplotlib, Creating graphs with NetworkX, Parsing HTML documents using Beautiful Soup.	**9**
3.	**Data Visualization** Visualizing Information: Starting with a Graph, Defining the plot, Drawing multiple lines and plots, Saving your work to disk, Setting the Axis, Ticks, Grids, Getting the axes, Formatting the axes, Adding grids, Defining the Line Appearance, Working with line style, Using colors, Adding markers, Using Labels, Annotations, and Legends, Adding labels, Annotating the chart, Creating a legend.	**7**
4.	**Data Wrangling** Wrangling Data: Playing with Scikit-learn, Understanding classes in Scikit-learn, Defining applications for data science, Performing the Hashing Trick, Using hash functions, Demonstrating the hashing trick, Working with deterministic selection, Considering Timing and Performance, Benchmarkin, with,timeit, Working with the memory profiler, Running in Parallel on Multiple Cores, Performing multicore parallelism, Demonstrating multiprocessing.	**8**
	Total	**30**

Text Book

1. Python for data science for dummies 2nd Edition, John Paul Mueller, Luca Massaron, Wiley
2. Programming through Python, M. T. Savaliya, R**. K. Maurya**, G. M. Magar, STAREDU Solutions
3. Pandas for everyone :Python Data Analysis, Daniel Y. Chen, Pearson

Reference Book

1. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools Davy Cielen, Arno D.B. Meysman, Mohamed Ali

Program:	M. Tech. (Artificial Intelligence & Data Science)			Semester : II		
Course :	Introduction to Neural Networks			Code : MDS2602B		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Prerequisite:

1. Linear Algebra
2. Mathematics

Objectives:

1. The main objective of this course is to provide the student with a basic understanding of neural networks fundamentals
2. Program the related algorithms and Design the required and related systems

Outcomes:

After learning the course, the students should be able to:

1. Demonstrate ANN structure and activation Functions
2. Define foundations and learning mechanisms and state-space concepts
3. Identify structure and learning of perceptions
4. Explain Feed forward, multi-layer feed forward networks and Back propagation algorithms
5. Analyze Radial Basis Function Networks, Regularization and RBF networks
6. Explain the Self Organizing Map

Detailed Syllabus:

Unit	Description	Duration Hrs
1.	**Introduction to Neural Networks:** Introduction and ANN Structure, Biological neurons and artificial neurons. Model of an ANN. Activation functions used in ANNs. Typical classes of network architectures.	6
2.	**Mathematical Foundation** Mathematical Foundations and Learning mechanisms. Re-visiting vector and matrix algebra, State-space concepts, Concepts of optimization, and Error-correction learning. Memory-based learning, Hebbian learning. Competitive learning.	8
3.	**Perceptrons** Single-layer perceptrons, Structure and learning of perceptrons, Pattern classifier, introduction and Bayes' classifiers, Perceptron as a pattern classifier, Perceptron convergence. Limitations of a perceptrons.	7
4.	**Feed Forward and Backpropagation NN:** Feed forward ANN, Structures of Multi-layer feed forward networks. Back propagation algorithm, Back propagation - training and convergence, Functional approximation with back propagation. Practical and design issues of back propagation learning	9
	Total	30

Text Books:

1. Introduction to Artificial Neural Systems, Jacek Zurada, West Publishing Company
2. Simon Haykin, "Neural Networks: A comprehensive foundation", Second Edition, Pearson Education Asia.
3. Satish Kumar, "Neural Networks: A classroom approach", Tata McGraw Hill, 2004

Reference Books:

1. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996
2. Pattern Recognition and Machine Learning, Christopher Bishop, 2007

MOOC Courses-

3. 1. Deep Learning Part-I, Swayam Prof. Mitesh M. Khapra
4. 2. Neural Networks and Deep Learning, Coursera, Andrew Ng
5. 3. Deep Learning for Computer Vision, Prof. Vineeth N Balasubramanian