Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

An Autonomous Institute Approved by AICTE AND Affiliated to SPPU, Pune

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Curriculum Structure and Syllabus

of

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

(Approved by BoS E&TC Engineering)

(Course 2020)

Effective from Academic Year 2020-21

VISION AND MISSION OF INSTITUTE

Institute Vision

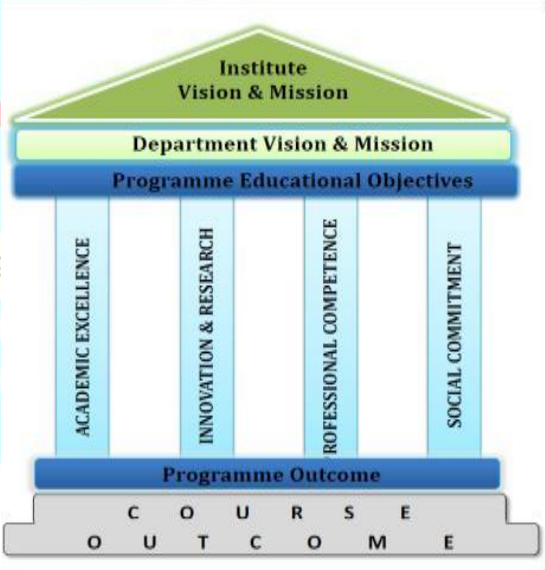
To Serve the Society, Industry and all the Stakeholders through the **Value-Added Quality Education.**

Institute Mission

To serve the needs of society at large by establishing State-of-the-Art Engineering, Management and Research Institute and impart attitude, knowledge and skills with quality education to develop individuals and teams with ability to think and analyze right values and self-reliance.

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 Management System.



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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

STRUCTURE FOR 1ST YEAR M. TECH (E&TC- VLSI AND EMBEDDED SYSTEMS)

SEMESTER – I

M.Tech Structure 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**

STRUCTURE FOR 1ST YEAR M. TECH (E&TC- VLSI AND EMBEDDED SYSTEMS)

SEMESTER – II

M.Tech Structure 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**

STRUCTURE FOR IIND YEAR M. TECH (E&TC- VLSI AND EMBEDDED SYSTEMS)

SEMESTER-III

M Tech Structure		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	-	50	-	-	50	100
OR												
MET3981	MOOC	MOOC's / Entrepreneurship	-	04	04	02	-	50	-	-	50	100
		Total	**-**	**28**	**28**	**14**	**-**	**150**	**-**	**50**	**200**	**400**

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

SEMESTER-IV

M Tech Structure		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	-	50	-	-	50	100
		Total	**-**	**28**	**28**	**14**	**-**	**250**	**-**	**-**	**250**	**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 ELECTIVE, AUDIT COURSE AND OPEN ELECTIVES

A. PROGRAMME ELECTIVE COURSE

	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

	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

B. 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

C. LIST OF OPEN ELECTIVES

FERED 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		**MCI2602C**	Operation Research

OFFERED BY INFORMATION TECHNOLOGY

	Open Elective – I		Open Elective –II
MIT1601A	Business Analytics	**MIT2602A**	Cryptography
MIT1601B	R Programming	**MIT2602B**	Cloud Computing and Security
MIT1601C	Cost Management of Engineering Project	**MIT2602C**	Bitcoin: Fundamentals of Crypto Currencies

Course Syllabus

Semester-I

Program:	M.Tech.(E&TC-VLSI and Embedded Systems)		Semester :	I		
Course :	Research Methodology and IPR		Code : MET1401			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Pre-requisite:

Objectives:

1. To understand some basic concepts of research and its methodologies
2. To identify appropriate research topics
3. To select and define appropriate research problem and parameters
4. To prepare a project proposal (to undertake a project)
5. To organize and conduct research (advanced project) in a more appropriate manner
6. To apply innovation and to get prepared to file an IP.

Outcomes:

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

1. Understand some basic concepts of research and its methodologies.
2. Identify appropriate research topics and define appropriate research problem and parameters.
3. Analyze a set of data, using standard procedures of mathematical modeling and predict the performance.
4. Write a research proposal to seek grants.
5. To write a concept note and prepare to file an IP.

Detailed Syllabus:

Unit	Description	Duration h
1.	**Introduction to Research** Meaning of Research, Objectives, Motivation, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Criteria of Good Research	4
2.	**Research Problem and Research Design** 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	4
3.	**Applied Statistics and Probability** **Sampling, Types of Sampling, Measures of Variability:** Standard Deviation, variance, Quartiles, Interquartile Range, Statistical Significance (p values), **Inferential Statistics:** Pearson's r test, t-test, Chi square test, ANOVA (Analysis of variance), **Probability Distribution:** Binomial Distribution, Poisson Distribution, Normal Distribution	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.	6
5.	**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 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.	6
6	**Intellectual property Rights** **Innovation process, Importance of Innovations in Research, Concept note** 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	**36**

Text Books:

1. Research Methodology: Methods and Trends, by Dr. C. R. Kothari
2. Research Methodology: An Introduction by Wayne Goddard and Stuart Melville
3. Research Methodology: A Step by Step Guide for Beginners, by Ranjit Kumar, 2nd Edition
4. Fundamentals of IPR by Ramkrishna B and Anil Kumar H S. , Notion Press
5. IPR in India by Virendra Kumar Ahuja, LexisNexis Butterworths Wadhwa Nagpur

Reference Books:

1. Stuart Melville ,Research methodology: an Introduction for Science & Engineering students,Wayne Goddard
2. Dr. S.D. Sharma, Kedar Nath Ram Nath & Co.,Operational Research

List of Assignments for IE 2.

1. Define a problem statement of the research project of your choice. Explain the research methodology you adopt to accomplish the task.
2. Construct a mathematical model and justify the predictive capability of the model for the research work.
3. Develop a research proposal asking for the financial assistant from the funding agency. (Use the format of proposal of any one of the funding agency like BCUD, ISRO, DST, DRDO, AICTE, SERB)
4. Prepare Concept Note and write Complete Specification of Patent / File Copyright/ file an Industrial Design.

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

Pre-requisite:

1. Basic understanding of MOSFETs
2. Basic fundamentals of integrated circuits.

Objectives:

1. Understand the fundamentals of CMOS Technology in Digital Domain.
2. Explore the skills of designing digital VLSI systems.
3. Understand design concepts of data path and memory subsystems

Outcomes:

1. To design basic logic circuits using CMOS technology and understand the fundamentals of CMOS layout.
2. To estimate the delay of logic networks and also analyse logical efforts
3. To design and analyse combinational and sequential circuits
4. To understand design principles and techniques of data path and memory subsystems

Detailed Syllabus:

Unit	**Description**	**Duration h**
1.	**MOS Transistor Theory and Analysis:** Basic Electrical Properties of MOS Circuits: Ids-Vds Relationships, MOS Transistor Threshold Voltage Vth, MOS Capacitance models, MOS Gate Capacitance Model, MOS Diffusion Capacitance Model, Technology scaling, Lambda parameter, 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: Delay in a Logic Gate, Delay in Multistage Logic Networks.	8
3.	**Logic Design:** Static CMOS Logic: Inverter, NAND Gate, Combinational Logic, NOR Gate, Compound Gates, Pass Transistors and Transmission Gates, Tristates, Multiplexers, Latches and Flip-Flops, Stick Diagram and Layout Design, Design calculations for combinational logic and active area on chip; Hazards, sources and mitigation techniques	6
4.	**FSM Design using HDL:** Concepts of FSMs, Types of FSMs, Basic design approach, HDL codes for FSM, Meta-stability issues and solutions; Timing analysis, Design Examples, Simulation and Synthesize using HDL	6
5.	**Data path Subsystems:** Adders, Multipliers, Comparators, Parity Generators, Registers and Counters	4
6.	**Memory Subsystems:** Introduction to SRAM, DRAM, ROM, Serial access memories; CAM	4
	Total	**36**

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.

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.

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

Pre-requisite:

1. Basics of Embedded system.

Objectives :

1. To understand need and application of ARM Microprocessors in embedded system.
2. To study of basics of the architecture of ARM series microprocessor
3. To understand architecture and features of typical ARM7& ARM 9 Processors.
4. To learn interfacing of real world input and output devices
5. To learn embedded communication systems.

Outcomes:

After learning the course the students should be able to:

1. Get knowledge about the basic functions of embedded systems.
2. Interface the advanced peripherals to ARM based microcontroller
3. Design embedded system with available resources.
4. Understand attributes of functional units of serial protocol

Detailed Syllabus:

Unit	**Description**	**Duration h**
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	**4**
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	**6**
4.	**Embedded Serial Communication:** Study of basic communication protocols like SPI, SCI (RS232, RS485), I2C, 10 CAN, Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee, Wireless sensor network	**8**
5.	**ARM-9 Architecture:** ARM-9-TDMI Processor core, ARM architectural support for high level language, ARM architectural support for system development, ARM architectural support for operating System, Memory subsystem architecture, Designing a cache system, Memory allocation, Communication protocols.	**6**
6.	**Embedded System Design Case Studies** Automated Meter Reading Systems (AMR), Digital Camera, Multimedia System, Electronic Control Unit (ECU) of Car and Medical Instrumentation.	**4**
	Total	**36**

Text Books:

1. David E.Simon, “An Embedded Software Primer”, Perason Education, 2003.

Reference Books:

1. Noergaard Tammy, “Embedded Systems Architecture”, Elsevier Publication.
2. Hallinan Christopher, “Embedded Linux Primer: A Practical Real-World Approach”, Second Edition, Pearson Education.
3. Shibu,”Introduction to Embedded Systems”, TMH.

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

Pre-requisite:

1. Front End Tools and Back End Tools basics
2. C Language basics and Interfacing basics

Objectives:

1. To understand the significance of CMOS design in VLSI
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 CMOS technology
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 **Three from Part A and Three from Part B**
2. **Total : 6 experiments 12 hours**

Detailed Syllabus:

Part A: CMOS VLSI Design (ANY Three)

Expt.	**Description**	**Duration H**
1.	To design, prepare layout and simulate CMOS Inverter for the given specifications of load capacitance, propagation delay, power dissipation, foundry etc.	**2**
2.	To design CMOS logic for F = A + B (C + D) + EFG and prepare layout. Assume suitable capacitive load & foundry. Measure TR, TF& TPD.	**2**
3.	To design and simulate combinational logic to demonstrate hazards. Also, simulate the same logic redesigned for removal.	**2**
4.	Design and simulate adder/multiplexer/decoders using CMOS and Transmission Gate.	**2**
	Total	**06**

Part B: Embedded System Design (ANY Three)

Expt.	**Description**	**Duration**
1.	Interfacing LPC2148 with GLCD to display image on it	**2**
2.	Interfacing EEPROM to LPC2148 using I2C protocol	**2**
3.	Interfacing USB & CAN of LPC 1768.	**2**
4.	Generate the square wave and use external interrupt to change the duty cycle of the square wave. (use LPC 2148)	**2**
	Total	**06**

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”, Perason 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”, Elsevier Publication.

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

Pre-requisite: Knowledge of digital signal processing

Objectives:

1. To provide complete overview of Digital Signal Processing with conceptual clarity.
2. To study the fundamentals of Multirate Digital Signal Processing and filter banks
3. To study the fundamentals and Multiresolution formulation of Wavelet Transform.
4. To develop the foundation of Adaptive filters for fixed- and floating-point implementations.
5. To study and analyze different applications of Digital Signal Processing.
6. To study and analyse fixed- and floating-point Digital Signal Processors.

Outcomes:

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

1. An ability to apply the knowledge of mathematics, science and engineering to analysis of Digital Signal Processing.
2. An ability to design multi rate signal processing of signals through systems.
3. An ability to design system using Wavelet Transform.
4. An ability to design Adaptive filters for fixed- and floating-point processors.
5. An ability to analyze and apply Digital Signal Processing in different areas.
6. An ability to implement the applications using Digital Signal Processors.

Detailed Syllabus:

Unit	**Description**	**Duration H**
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.	6
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.	6
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.	4
5.	**UNIT–V: Applications of DSP** Speech Processing, Digital Radio, Digital Television, Radar, Biomedical signal Processing: Electrocardiogram, Electroencephalogram, Electromyogram.	4
6.	**UNIT-VI: Digital Signal Processor** Digital Signal Processor Architectures: Introduction, Central Processing Unit operations, Memory Configurations, Peripherals and Input/Output. Fixed-Point Digital Signal Processors: Introduction, TMS320C54x Floating-Point Digital Signal Processors: Introduction, TMS320C67x	**8**
	Total	**36**

Text Books:

1. John G. Proakis ,Digital Signal Processing principles –algorithms and Applications-–PHI – 3rd edition 2002.
2. Glenn Zelniker, Fred J. Taylor.,Advanced Digital Signal Processing – Theory and Applications –
3. Simon Haykin, “Adaptive Filt a. er Theory”, Prentice Hall, Englehood Cliffs
4. M.Kuo, Woon-Seng Gan ,Digital Signal Process0rs Architectures, Implementations and Applications-Sen, Pearson Education

Reference Books:

1. S Salivahanan. A Vallavaraj C. Gnanapriya ,Digital Signal Processing —TMH – 2nd reprint 2001.
2. Sanjit K. Mitra ,Digital Signal Processing — TMH second edition.
3. Lourens R Rebinarand Bernold, ,Theory and Applications of Digital Signal Processing –Prentice-Hall of India, 2006.
4. Kayvan Najarian • Robert Splinter vBiomedical Signal and Image Processing - -CRC press

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

Pre-requisite: Basics of Electronics and Electrical, Digital Electronics

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 h**
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.	**6**
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.	**6**
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,	**4**
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	**6**
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.	**6**
	Total	**36**

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

Pre-requisite:

1. Basics of VLSI Design Flow,Basics of VHDL

Objectives:

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

Outcomes:

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

1. Analyse physical design problems and employ appropriate automation algorithms for partitioning, floor planning, placement and routing
2. Analyse the performance issues in circuit layout using analytical and CAD tools.

Detailed Syllabus:

Unit	**Description**	**Duration h**
1.	Role of CAD in digital system design, levels of design, modeling & description and support of languages, RTL, gate and system level synthesis	**6**
2.	Introduction to VLSI design methodologies and supporting CAD environment. Basics of VLSI Physical Design flow. Circuit partitioning, placement and routing algorithms.	**6**
3.	Design Rule-verification, Circuit Compaction; Circuit Extraction and post layout simulation	**6**
4.	FPGA design flow- partitioning, placement and routing algorithms.	**6**
5.	CAD tools for synthesis, optimization, simulation and verification of design at various levels. Technology mapping for FPGAs.	**6**
6.	Recent topics in CAD-VLSI: Array compilers, hardware software co-design, high-level synthesis tools and VHDL modeling.	**6**
	Total	**36**

Text Books:

1. G. D. Micheli, Synthesis and Optimization of Digital Circuits. McGraw Hill, 1994.
2. T. H. Cormen, C. E. Leiserson and R. L. Rivest, "Introduction to Algorithms," McGraw-Hill, 1990.
3. Stephen Trimberger," Introduction to CAD for VLSI", Kluwer Academic publisher, 2002

4. Reference Books:

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

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

Pre-requisite:

1. Basic understanding of VLSI Design and Embedded Processor Architectures
2. Knowledge of Embedded 'C', VHDL and Programming flow of VLSI and Embedded softwares

Objectives:

1. To make student understand 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 design of SoC for various real time application

Outcomes:

After learning the course the students should be able to:

1. Understand concept of Processor Architecture, Micro-programmed Architecture and its significance in SoC design.
2. Understand SoC Modelling, Memory Design, interfacing and SoC Performance Metric.
3. Gain knowledge of SoC Prototyping, Hardware and Software Design flow of SoC Design, SoC Verification and Testing.
4. Design application oriented SoC design and its physical design principles.

Detailed Syllabus:

Unit	**Description**	**Duration h**
3.	**Basic Concepts:** 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.	**6**
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.	**6**
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.	**4**
4.	**Micro-programmed Architecture:** Micro-programmed : control, encoding, data-path, Micro-programmed machine implementation, SOC modelling, hardware/software interfaces , SOC Standard Buses and interconnects synchronization schemes, memory mapped Interfaces , coprocessor interfaces, coprocessor , control shell design, data and control design, Programmer's model.	**8**
5.	**Research topics in SOC design:** SOC Design approach, AES algorithms, A SOC controller for digital still camera, portable multimedia system, Image compression – JPEG compression. SoC Platforms OMAP 137, PSoC 3 and PSoC 5.	**6**
6.	**Performance Metric** : Importance of low power, causes and factors affecting power, switching activity, factors affecting delay and slew, sequential arcs, clock domain crossing and Static Timing Analysis.	**6**
	Total	**36**

Text Books:

1. Patrick R. Schaumont, "A Practical Introduction to Hardware/Software Co-design",Springer Publications.

2. Youn-Long Steve Lin, "Essential Issues in SOC Design, Designing Complex Systems-onChip", Springer Publications.

3. Wayne Wolf, "Modern VLSI Design Systems on Chip", Pearson Education.

Reference Books:

1. ARM System on Chip Architecture – Steve Furber –2nd Ed., 2000, Addison Wesley Professional.

2. System on Chip Verification – Methodologies and Techniques – Prakash Rashinkar, Peter Paterson and Leena Singh L, 2001, Kluwer Academic Publishers.

3. Rajanish K. Kamat, Santhosh A. Shinde, Vinod G. Shelake, "Unleash the System On Chip using FPGAs and Handel C", Springer Publications

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

Pre-requisite: Basics of Embedded Systems, VHDL programming

Objectives:
1. To learn architecture fundamentals of processor design
2. To understand memory management of CISC and RISC processors
3. To gain 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. Visualize probable Problems, fallacies and Pitfalls in Processor Design
2. Understand Extreme CISC and RISC, Very Long Instruction Word (VLIW), overly aggressive pipelining, unbalanced processor
3. Gain skills to implement Processor functional components like MAC

Detailed Syllabus:

Unit	**Description**	**Duration h**
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.	**6**
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.	**6**
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 ofprocessor customization, use of microprocessor cores in SOC design, benefits of microprocessor extensibility.	**6**
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.	**6**
	Total	**36**

Text Books:

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

Reference Books:

1. Leibson S, Tensilica, "Customizable Processors and Processor Customization".
2. Campi F, "Run-Time Reconfigurable Processors".
3. Garside J, Furber S, "Asynchronous and Self-Timed Processor Design".
4. Rusu S, "Processor Clock Generation and Distribution".
5. 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

Pre-requisite: System Programming and Operating Systems, Embedded Systems

Objectives:

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

Outcomes:

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

1. Understand the embedded Linux.
2. Develop the code for drivers in embedded Linux.
3. Develop the applications in embedded Linux.

Detailed Syllabus:

Unit	Description	Duration h
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	**6**
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	**6**
3.	**Host-target development setup:** Development languages and tools, Hardware support, Debug setups, Boot Configurations, Processor architectures supported by Linux	**6**
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 subsystems, Busybox	**6**
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/O interfacing	**6**
	Total	**36**

Text Books:

1. Embedded Linux, Pearson
2. Edward A. Lee, "Embedded Software", Advances in Computers (M. Zelkowitz, editor) 56, Academic Press, London, 2002.
3. Bruce Powel Douglass, Newnes , Design Patterns for Embedded Systems in C: An Embedded Software Engineering, , Elsevier.
4. Robert Oshana, Mark Kraeling, Newnes ,Software Engineering for Embedded Systems: Methods, Practical Techniques, Elsevier.
5. Jean J. Labrosse, Embedded Software, Newnes know it all series, Elsevier. , ISSN 1879-8683,
6. R and D Developer Series, Qing Li, Caroline Yao,Real-Time Concepts for Embedded Systems, CMP books, CRC press.
7. Doug Abbott ,Linux for Embedded and Real-time Applications, , Newnes, Elsevier, 2003.

Reference Books:

1. Karim Yaghmour, Jon Masters, Gillad Ben Yossef, Philippe Gerum, “Building embedded linux systems”, O'Reilly, 2008.
2. Christopher Hallinan, “Embedded Linux Primer: A practical real world approach”, Prentice Hall, 2007.
3. Craig Hollabaugh, “Embedded Linux: Hardware, software and Interfacing”, Pearson Education, 2002.
4. Doug Abbott, “Linux for embedded and real time applications”, Elsevier Science, 2003.

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

Pre-requisite:

- Knowledge of digital signal processing, Basics of VLSI Design Flow
- Basics of VHDL, Embedded C and MATLAB

Objectives:

1. To provide complete overview of Digital Signal Processing with conceptual clarity.
2. To understand the concepts of physical design process such as partitioning, Floor-planning, Placement and Routing.
3. To provide knowledge of Hardware and Software Design flow of SoC Design.
4. 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. Design multi rate signal processing of signals using MATLAB/ Code Composer.
2. Analyse the performance issues in circuit layout using analytical and CAD tools.
3. Understand SoC Modelling, Memory Design, interfacing and SoC Performance Metric.
4. Program various applications using Front End and Backend Tools, MATLAB and C.

Guidelines :

1. Total experiments to be conducted are **Three from Part A and Three from Part B**
2. **Total : 6 experiments 12 hours**

Detailed Syllabus:

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

Expt.	**Description**	**Duration h**
1.	To implement and verify linear and Circulation convolution.	**2**
2.	To implement and verify Correlation.	**2**
3.	Implementation of Decimation and Interpolation.	**2**
4.	Implementation of Audio/Image /Video processing using Digital Signal Processor.	**2**
	Total	**06**

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

Expt.	**Description**	**Duration h**
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**
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.	**2**
3.	Characterize n-MOSFET and p-MOSFET to find out low frequency C-V characteristics behavior with the given model parameters.	**2**
4.	Characterize n-MOSFET and p-MOSFET to find out high frequency C-V characteristics behavior with the given model parameters.	**2**
	Total	**06**

Part A: Elective 1- CAD Algorithms for VLSI Design (ANY Three)		
Expt.	**Description**	**Duration h**
1.	Design, synthesis, simulation and implementation of 4 bit ALU on Xilinx and download onto FPGA.	**2**
2.	Introduction to layout design rules Layout, physical verification, placement & route and static timing analysis for CMOS inverter	**2**
3.	Layout, physical verification, placement & route and static timing analysis for CMOS NOR and NAND gate	**2**
4.	Introduction to SPICE simulation and coding of NMOS/CMOS circuit	**2**
	Total	**06**
Part B: Elective 2- System on Chip(ANY Three)		
Expt.	**Description**	**Duration h**
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**
2.	Design and implement MOD4 counter on PLD and verify multi-clock operations	**2**
3.	Design and implement FSMD for Euclids GCD	**2**
4.	Implement temperature logging system as a co-design by Interfacing FPGA &μC	**2**
	Total	**06**
Part B: Elective 2- Embedded Processor Architecture and Design (ANY Three)		
Expt.	**Description**	**Duration h**
1.	Design and implement MAC Unit on PLD	**2**
2.	Design and implement CPU on PLD	**2**
3.	Design and implement Carry look-ahead generator on PLD	**2**
4.	Design and implement 4 bit processor for 4 arithmetic and 4 logical operations.	**2**
	Total	**06**
Part B: Elective 2- System Design with Embedded Linux **(ANY Three)**		
Expt.	**Description**	**Duration h**
1.	Bootloader compilation and downloading on Target board.	**2**
2.	Download pre-compiled Linux kernel images on Target board. Configure and boot an embedded Linux relying on block storage	**2**
3.	Develop character device driver for GPIO.	**2**
4.	Write a program for External Interrupt Handling.	**2**
	Total	**06**

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

Reference Books:

1. Naveed Shervani, "Algorithms for VLSI physical design Automation", Kluwer Academic Publisher, Second edition.
2. Christopher Hallinan, "Embedded Linux Primer: A practical real world approach", Prentice Hall, 2007.
3. Patrick R. Schaumont, "A Practical Introduction to Hardware/Software Co-design",
4. Springer Publications.
5. Prakash Rashinkar, Peter Paterson and Leena Singh L System on Chip Verification – Methodologies and Techniques –,Kluwer Academic Publishers, 2001.

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

Pre-requisite:
Basics of C, MATLAB, Python, VHDL

Objectives:

1. To strengthen the software programming skills of the students.
2. To strengthen the hardware programming skills of the students.
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 experiment 5-8.**

2. Total : 6 experiments 12 hours

Detailed Syllabus:

Skill Development Lab (ANY Six)

Expt.	**Description**	**Duration h**
1.	Execute the Xilinx ISE tool design flow and verify for various modelling styles of VHDL with suitable examples on FPGA	**2**
2.	Execute Vivado tool design flow and implement 4 bit counter using FPGA	**2**
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	**2**
4.	Execute Mentor graphics Tool HEP-I and HEP-II Design Flow with simple example.	**2**
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.	**2**
6.	Explore ARM9/ ARM cortex Board using Embedded Linux and interface simple I/Os	**2**
7.	Explore Python Design flow for implementing design on hardware boards such as Raspberry Pi or Arduino	**2**
8.	Explore Code Composer Studio and OMAP 138 board for simple application.	**2**
	Total	**12**

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 Composer Studio:
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 :**	**MET2405**
Teaching Scheme				**Evaluation Scheme**		
Lecture	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**Total**
3	3	3	20	30	50	100

Pre-requisite:

1. Basic understanding of MOSFETs
2. Basic fundamentals of analog integrated circuits.

Objectives:

1. To understand concepts of analog circuits design using MOS small signal models
2. To understand design principles and techniques of CMOS sub-circuits and CMOS Amplifiers
3. To learn different methods of Stability and Frequency Compensation
4. To gain design aspects of Low Noise Amplifiers

Outcomes:

After learning the course the students should be able to:

1. Describe the small signal models MOS technologies
2. Analyze and design current sources and voltage references
3. Analyze and design single-ended and differential amplifiers
4. Analyze and design operational amplifiers

Detailed Syllabus:

Unit	**Description**	**Duration H**
1.	**Introduction to Analog VLSI:** Analog integrated circuit design, Circuit design consideration for MOS challenges in analog circuit design, recent trends in analog VLSI circuits. Analog MOSFET Modeling : MOS transistor, Low frequency MOSFET Models, High frequency MOSFET Models, temperature effects in MOSFET, Noise in MOSFET	6
2.	**CMOS Sub circuits:** Current Source, Sinks and References MOS Diode/Active resistor, Simple current sinks and mirror, Basic current mirrors, advance current mirror, Current and Voltage references	6
3.	**CMOS Amplifier:** Performances matrices of amplifier circuits, Common source amplifier, Common gate amplifier, Common Drain amplifier, Cascode-Folded Cascode amplifier, Frequency response of amplifiers and stability of amplifier.	6
4.	**CMOS Differential Amplifier:** Differential signalling, source coupled pair, Current source load, CMOS Differential amplifier with current mirror load, Performance parameters, Differential to single ended conversion	6
5.	**CMOS Operational Amplifier:** Block diagram of Op-amplifier, Ideal characteristics of Op-Amplifier, Design of two stage Op Amplifier, Compensation of Op-Amplifier, Frequency response of Op-Amplifier, Operational Transconductance Amplifier (OTA).	6
6.	**Low Noise Amplifier Design:** Low Noise Amplifier (LNA) design, noise and power trade off, optimizations, Design of mixer, Advanced trends in Radio Frequency (RF) chip design.	6
	Total	**36**

Text Books:

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, Boston: McGraw Hill, 2001.
2. D.A. Johns and K. Martin, Analog Integrated Circuit Design, New York: Wiley, 1997. P.E.

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.

Program:	**M. Tech. (E&TC)-VLSI and Embedded Systems**			**Semester :**	**II**	
Course :	**Embedded System Programming and RTOS**			**Code :**	**MET2406**	
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
2	2	1	20	30	50	100

Pre-requisite:

Basic computer architecture and Operating Systems, Basic programming skills.

Objectives:

1. To understand and able to design an application specific systems.
2. To develop implementation skill for application specific systems.
3. To understand design and implementation of real time system using RTOS.
4. To understand open source platform for embedded system

Outcomes:

After learning the course the students should be able to:

1. To understand the working of real-time operating systems.
2. To develop real-time algorithm for task scheduling and inter-process communication.
3. Students will be able to understand the hardware – software co design issues and testing methodology for embedded system.

Detailed Syllabus:

Unit	**Description**	**Duration h**
4.	**Embedded System Overview** Embedded System Introduction, Hardware and software architectures of ES, Design metrics (technical and techno- economical), Prototyping models, Development tool chain insights (GNU), Embedded C programming, embedded system design challenges, standard programming practices in embedded system.	**4**
2.	**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. **Concepts of RTOS:** Tasks and Task states – Semaphores – Shared data – Message queues, Mail boxes and pipes – Memory management– Interrupt routines – Encapsulating semaphore and queues – Hard Real-time scheduling – Power saving.	**8**
3.	**µcos-II –RTOS** µcos-II features, kernel structure, data structure, µcos-II services as task management,	**6**

	time management, inter-process communication (mailbox, queue, events, pipes, etc.), memory management. µcos-II porting on ARM7/Cortex (M3/M4) architecture.	
4.	**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.	**6**
5.	**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.	**6**
6.	**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, Telephony and SMS, Audio Video using the Camera, Project Discussion on Android. platform.	**6**
	Total	**36**

Text Books:

1. Frank Vahid and Tony Givargis, "Embedded system design: a unified hardware/software Introduction", Wiley , 2002.
2. Rajkamal, Embedded Systems: Architecture, Programming and Design, Tata McGraw-Hill Education
3. Joseph Yiu, The Definitive Guide to the ARM Cortex-M3. Newnes.
4. Hallinan Christopher, “Embedded Linux Primer: APractical Real-World Approach”, Second Edition, Pearson Education.

Reference Books:

1. Programming 32-bit microcontrollers in C, Di Jasio
2. Noergaard Tammy, “Embedded Systems Architecture”, Elsevier Publication.
3. Embedded multitasking, K. Curtis
4. S. Stavitzky, Real-time microprocessor systems, Van Nostrand Reinhold Co.
5. Chris Simmonds, Master the techniques needed to build great, efficient embedded devices on Linux, Packt.

Program:	**M.Tech (E&TC)-VLSI and Embedded Systems**				**Semester :**	**II**
Course :	**Professional Core Lab-II**				**Code :**	**MET2406**
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
2	2	1	50	--	50	50

Pre-requisite:

1. Front End Tools and Back End Tools
2. C Language basics and Interfacing basics
3. Operating Systems basics

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 uCos-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 interprocess communication protocols

Guidelines :

1. Total experiments to be conducted are **Three from Part A and Three from Part B**
2. **Total : 6 experiments 12 hours**

Detailed Syllabus:

Part A: Advanced CMOS Design (ANY Three)

Expt.	**Description**	**Duration h**
1.	Design and prepare layout of MOS current sources and current mirrors.	**2**
2.	Design and simulation of common source amplifier.	**2**
3.	To design, prepare layout and simulate CMOS differential amplifier for DC gain of 40 dB.	**2**
4.	Comment on UGB, phase margin, CMRR	**2**
	Total	**06**

Part B: Embedded System Programming and Real time OS (ANY Three)

Expt.	**Description**	**Duration h**
1.	Porting of ucos-II on ARM7 controller. Implementation/Verification of multitasking (minimum 03 tasks) with ucos-II on ARM7 controller.	**2**
2.	Implementation of semaphore with ucos –II service ARM7 controller for resource management and synchronization.	**2**
3.	Programming on motor control with exploring on-chip PWM of Cortex based microcontroller.	**2**
4.	Exercise on Porting of Linux on ARM9 board Writing simple application using embedded Linux on ARM9	**2**
5.	**Total**	**06**

Text Books:

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, Boston: McGraw Hill, 2001.
2. D.A. Johns and K. Martin, Analog Integrated Circuit Design, New York: Wiley, 1997. P.E.
3. Rajkamal, Embedded Systems: Architecture, Programming and Design, Tata McGraw-Hill Education
4. Joseph Yiu, The Definitive Guide to the ARM Cortex-M3. Newnes.

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. , Di Jasio ,Programming 32-bit microcontrollers in C
4. Tammy Noergaard, Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers, Newnes.

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

Pre-requisite: Basics of VLSI design Flow, Basics of FPGA

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. Design, implement and analyze reconfigurable systems in the recent application domains using HDL
3. Use advanced EDA tools to simulate and synthesize HDL codes for reconfigurable architectures

Detailed Syllabus:

Unit	**Description**	**Duration h**
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.	**6**
2.	Architecture of Field Programmable Gate Arrays, Reconfigurable Processing Fabric (RPF) Architectures: Fine grained, Coarse-Grained	**6**
3.	Integration of RPF into Traditional Computing Systems, Early systems of Reconfigurable computing: PAM, VCC, Splash, PRISM, Teramac, Cray, SRC	**6**
4.	Reconfiguration Management: Reconfiguration, Configuration architectures, managing reconfiguration process, reducing reconfiguration time, configuration security	**6**
5.	FPGA Design Flow, System On A Programmable Chip: Introduction to SoPC, Adaptive Multiprocessing on Chip.	**6**
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	**36**

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

Pre-requisite: Knowledge of Embedded system, Basics of Computer Network.

Objectives:

1. To understand 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 understand fundamentals of security in IoT,
5. To learn to implement secure infrastructure for IoT
6. To learn 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. Implement an architectural design for IoT for specified requirement
2. Solve the given societal challenge using IoT
3. Choose between available technologies and devices for stated IoT challenge

Detailed Syllabus:

Unit	**Description**	**Duration H**
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	6
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	6
3.	IoT Protocols and Security ,Protocol Standardization for IoT, M2M and WSN Protocols, SCADA and RFID Protocols, Issues with IoT Standardization, Unified Data Standards, Protocols – IEEE 802.15.4, BACNet Protocol, Modbus, KNX, Zigbee Architecture, Network layer, APS layer.	6
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, Cloud Offerings and IoT Case Studies • Introduction to Cloud Storage Models, Communication API, • WAMP: Autobahn for IoT,.	6
6.	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 Irrigation	**6**
	Total	**36**

Text Books:

1. Hakima Chaouchi, ― The Internet of Things Connecting Objects to the Web‖ ISBN : 978- 1-84821-140-7, Wiley Publications
2. Olivier Hersent, David Boswarthick, and Omar Elloumi, ―The Internet of Things: Key Applications and Protocols‖, Wiley Publications
3. Vijay Madisetti and Arshdeep Bahga, ―Internet of Things (A Hands-on-Approach), 1st Edition, VPT, 2014.

Reference Books:

1. Vijay Madisetti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach”
2. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"
3. 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
4. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies,Platforms, and Use Cases", CRC Press

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

Pre-requisite: Basics of FPGA, CPLD and ASIC

Objectives:

To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.

1. To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.
2. 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 issues involved in ASIC design, including technology choice, design management, tool-flow, verification, debug and test, as well as the impact of technology scaling on ASIC design.
2. To have experience with a logic synthesis tool for mapping RTL onto a cell library
3. Understand the algorithms used for ASIC design.
4. To understand the role of computer-aided design (CAD) tools in automating the design flow and providing improved productivity in VLSI systems design.

Detailed Syllabus:

Unit	**Description**	**Duration h**
1.	IC Design Technologies, VLSI Design flow, Programmable ASICs - Antifuse, SRAM, EPROM, EEPROM based ASICs. Programmable ASIC logic cells, I/O cells and programmable interconnects. Latest Version - FPGAs and CPLDs and Soft-core processors.	**6**
2.	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	**6**
3.	System Partitioning algorithms, Power Dissipation, ASIC floor planning, Placement and Routing.	**6**
4.	ASIC construction with goals, objectives and various algorithms for system partitioning, floor-planning, placement and routing, mixed mode design and simulation, SI issues. Parameter extraction with Post layout simulation and Pre layout simulation.	**6**
5.	DFT in ASIC, Testing techniques used in ASIC like Automatic test pattern generation, BILBO, Scan test, Partial Scan, Built in self test and JTAG. Brief view of Stuck at fault models and fault simulation	**6**
6.	ASIC Verification and its issues, Types and features of existing available EDA tools. High performance algorithms for ASICS/ SoCs as case studies	**6**
	Total	**36**

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: 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

Pre-requisite: Knowledge of automotive electronics, embedded systems, control systems, communication engineering, etc.

Objectives:

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

Outcomes:

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

1. Develop, simulate and integrate control algorithms for ECUs with hardware
2. Understand the networking of various modules in automotive systems and communication protocols of interfacing different electronics components, systems and functional counterparts.
3. To interface devices and build a complete automotive control system.

Detailed Syllabus:

Unit	Description	Duration h
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)	**6**
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	**4**
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	**4**

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	**6**
	Total	**36**

Text Books:

1. William B. Ribbens, "Understanding Automotive Electronics- An Engineering Perspective", Seventh edition, Butterworth-Heinemann Publications.
2. Tao Zhang, Luca Delgrossi, "Vehicle Safety Communications: Protocols, Security and Privacy", 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

Pre-requisite:

1. Knowledge of Microcontroller, sensors and interfacing
2. Programming understanding and Knowledge of Embedded C, MATLAB

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 concept of bio-electric signals such as EEG, ECG and EMG and its relevance for normal and abnormal state
2. Design real time pre-processing system required for medical signal processing and medical imaging.
3. To design hardware considering the trade-off between area, performance and power consumption, depending on the application.
4. 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.	**4**

5.	**Medical Imaging:** Magnetic Resonance Imaging: Introduction, principles of MRI and fMRI, MRI instrumentation, image acquisition and reconstruction techniques, Application of MRI	**4**
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	**36**

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

Pre-requisite:
1. Conceptual understanding of combinational and sequential digital circuits
2. Knowledge of frontend and backend design tools.

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 observability and controllability parameters of circuit
3. Enhance testability of a circuit
4. Use simulation techniques for designing and testing of VLSI circuits

Detailed Syllabus:

Unit	**Description**	**Duration h**
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.	6
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.	6
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.	4
6.	**Verification Methodologies :** Functional verification: . OVM, UVM, VVM, Timing verification. Basics of equivalence checking and model checking. Hardware emulation System Verification	4
	Total	**36**

Text Books:

1. Bushnell M L, Agrawal V D, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers.
2. Abramovici M, Breuer M A and Friedman A D, "Digital systems and Testable Design", Jaico Publications.
3. Kropf T, "Introduction to Formal Hardware Verification," Springer Publications.

Reference Books:

1. Crouch A L, "Design Test for Digital IC's and Embedded Core Systems", Prentice Hall.
2. Rolf Drechsler, "Advanced Formal Verification" Kluwer Academic Publishers.

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

Pre-requisite:

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

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. Implement an architectural design for IoT for specified requirement
2. Understand the role of computer-aided design (CAD) tools in automating the design flow and providing improved productivity in VLSI systems design.
3. Develop, simulate and integrate control algorithms for ECUs with hardware
4. Program various applications using Front End and Backend Tools, MATLAB, Python and C.

Guidelines :

1. Total experiments to be conducted are **Three from Part A and Three from Part B**

2. Total : 6 experiments 12 hours

Detailed Syllabus:

Part A: Elective III- Reconfigurable Computing **(ANY Three)**

Expt.	Description	Duration h
1.	Implementation of Audio/Image /Video processing using Digital Signal Processor. Introduction to FPGA tool Flow with case study: 4 bit ALU	2
2.	Top level modular and hierarchical designs of Adder and Subtractor such that they can be replaced.	2
3.	Design of adaptive LED shifter which shifts in Right or Left shift using a selector	2
4.	Design of Multi Context (4) 4-LUT using HDL and implement on FPGA.	2
	Total	06

Part A: Elective III- IOT in Embedded System (ANY Three)

Expt.	Description	Duration h
1.	Weather forecasting system using any cloud applications and IoT hardware platforms.	2
2.	Smart Agriculture irrigation System.	2
3.	Motion detection-based Intrusion detection and alert system.	2
4.	Smart Air pollution monitoring system.	2
	Total	06

Part A: Elective III - ASIC Design (ANY Three)		
Expt.	**Description**	**Duration h**
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**
2.	Draw CMOS layout in selected technology, simulate with and without capacitive load, comment on rise, and fall times.	**2**
3.	To detect stuck at fault, perform fault Simulation and generate test vectors of given model.	**2**
4.	Write HDL code for BIST.	**2**
	Total	**06**
Part A: Elective IV- Embedded System for Automotive Applications **(ANY Three)**		
Expt.	**Description**	**Duration h**
1.	Study of 32-bit automotive grade controller board. Writing code in IDE. Flashing code & testing.	**2**
2.	Introduction to Simulink and SimDriveline for modelling an automotive control system.	**2**
3.	Deploy a control algorithm on a real-time target. Download the software from Host Machine to target Machine.	**2**
4.	Implement any one application prototype from below: Adaptive cruise control, Engine Management System, Power windows and automotive lighting system, etc.	**2**
	Total	**06**
Part A: Elective IV- Embedded Systems in Biomedical Applications **(ANY Three)**		
Expt.	**Description**	**Duration h**
1.	Design and implement DWT for EEG / ECG Signal Processing using MATLAB / Python	**2**
2.	Design and implement HRV detection using MATLAB / Python	**2**
3.	Design and implement any abnormality detection in brain using MRI or fMRI (MATLAB / Python / OMAP)	**2**
4.	Design and implement real time invasive/ non-invasive glucose measurement system using PSoC or OMAP	**2**
	Total	**06**
Part A: Elective IV- VLSI Testing and Design for Testability **(ANY Three)**		
Expt.	**Description**	**Duration h**
1.	Evaluate SSF, MSF and Bridging Faults using backend tools	**2**
2.	Design Automatic Test Pattern Generator for 4 bit adder using Xilinx ISE	**2**
3.	Writing Test cases for testing combinational circuit.	**2**
4.	Case Study: Verification of processor architecture	**2**
	Total	**06**

Text Books:

1. G. D. Micheli, Synthesis and Optimization of Digital Circuits. McGraw Hill, 1994.
2. Bushnell M L, Agrawal V D, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers.
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
5. AUTOSAR Documentation [on line]. Available on: www.autosar.org

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. M. Gokhale and P. Graham, Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays, Springer, 2005.
4. Vijay Madisetti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach”

Program:	**M. Tech (E&TC)-VLSI and Embedded Systems**			**Semester :**		**II**
Course :	**Skill Development Lab – II (Oral & Written Communication)**			**Code :**		**MET2101**
Teaching Scheme			**Evaluation Scheme**			
Practical	**Hours**	**Credit**	**TW**	**PR**	**OR**	**Total**
2	2	1	50	--	--	50

Pre-requisite: 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 behavioural 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. Operate effectively in multi disciplinary and heterogeneous teams through the knowledge of team work, inter personal relationships, conflict management and leadership activities

Guidelines :

1. Total experiments to be conducted are **any six from 8 experiments.**
2. **Total : 6 experiments 12 hours**

Detailed Syllabus:

Skill Development Lab (ANY Six)

Expt.	**Description**	**Duration h**
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**
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)	**2**
3.	**Writing An Article On Any Social Issue:** Build writing skills, improve language and gain knowledge about how to write an article/ report	**2**
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.	**2**
5.	**Debate On Current Affairs/ Social Relevance Topics:** Cultivate the habit to present forceful arguments while respecting the opponents perspective and enhance verbal skills.	**2**
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	**2**

	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.	**2**
8.	**Mock interviews:** Guide students and conduct mock interviews	**2**
	Total	**12**

Text Books:

1. Barun Mitra, Personality Development and Soft Skills
2. *Stephen Lucas,The Art of Public Speaking*

Reference Books:

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

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

Pre-requisite:

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

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 : 36 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 h**
1.	Week 1 &2 : Mini-project guide allotment, finalization of topic and platform, Planning of the work	**6**
2.	Week 3&4: Literature review and specification and Methodology Finalization, Review 1 for finalization of topic and specification.	**6**
3.	Week 5&6 : Simulation of Idea on appropriate software tools and finalization of hardware platform	**6**
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	**6**
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.	**6**
	Total	**36**

Reference:

1. Robert Boylested, ― Essentials of Circuit Analysis‖, PHI Puublications
2. Thomas C Hayes, Paul Horowitz,, ―The Art of Electronics‖,Newens Publication
3. A.E. Ward, Angus, ― Electronic Product Design‖, Stanley thornes Publishers, UK.

Annexure-I
Open Elective Syllabus

LIST OF OPEN ELECTIVES

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		**MCI2602C**	Operation Research

OFFERED BY INFORMATION TECHNOLOGY

	Open Elective – I		Open Elective –II
MIT1601A	Business Analytics	**MIT2602A**	Cryptography
MIT1601B	R Programming	**MIT2602B**	Cloud Computing and Security
MIT1601C	Cost Management of Engineering Project	**MIT2602C**	Bitcoin: Fundamentals of Crypto Currencies

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

Pre-requisite:

Thermodynamics, Fluid Mechanics, Heat Transfer

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.	06
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	06
3.	**Packaging of Electronic Equipments** Components of Electronic Systems, Packaging of Electronic Equipment, Conduction Cooling for Chassis and Circuit Boards, Chip/circuit material for augmenting heat transfer.	06
4.	**Control Parameters Measurement and simulation** Temperature & humidity requirement, CFD analysis for Airflow & temperature evaluation, thermography etc	06
	Total	24

Text Books:

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

Reference Books:

1. Joel L. Sloan, "Design and Packaging of Electronic Equipment", Van Nostrand Reinhold Company, 1985.
2. Belady C., "Standardizing Heat Sink Performance for Forced Convection, Electronics Cooling", Vol. 3, No. 3, September, 1997.
3. Biber C., Wakefield Engineering, Wakefield, Massachusetts, "Characterization of the Performance of Heat Sinks,", Personal Communication, October 1997.
4. Avram Bar-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 Open					Code: MMH1601B	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE 1	IE 2	ETE	Total
2	-	-	2	20	-	30	50

Pre -requisite:

Basics of air conditioning
Basics of building construction

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 be able to:

1. Should be able to identify features of an energy efficient building system
2. Learner should be able to apply simulation programs of buildings to perform energy calculations, evaluate the relationship between energy use, indoor comfort
3. Learner should be able to evaluate and justify energy-saving measures in existing building on the basis of engineering and economic feasibility
4. Learner should be able to apply the principles of energy management to obtain buildings that can be certified

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	**06**
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	**06**
3	**Health and Wellness** 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	**04**
4	**Site features** 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	**02**
5	**Materials and resources** 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,	**05**
6	**Government schemes and incentive programs** Funding and Incentives for green building rating programs, requirements of NBC 2016 related to sustainability, local byelaws, model building code	**01**
	Total	**24**

Text Books:

7. Shahane, V. S, "Planning and Designing Building", Poona, Allies Book Stall, 2004.
8. Michael Bauer, Peter Mösle and Michael Schwarz "Green Building – Guidebook for Sustainable Architecture" Springer, 2010.
9. Tom Woolley, Sam Kimmins, Paul Harrison and Rob Harrison "Green Building Handbook" Volume I, Spon Press, 2001.
10.

Reference Books:

1. Mili Majumdar, "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. (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**

Pre-requisite:

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 h**
1.	Introduction to Modelling and Simulation, Basic systems, Introduction and Types of Mathematical modelling, Basic building blocks Mechanical, Electrical, Thermal systems.	**6**
2.	Bond Graph Modelling of Dynamic Systems: Representation,Elements, Single,Two and multiports Causality, Application to basic Mechanical,Electrical and Electromechanical system	**6**
3.	Dynamic Response and System Transfer Function: Poles, Stability Block diagram/Signal flow diagram/State Space formulation and Frequency response	**6**
4.	Simulation and Simulation application Parameter Estimation, System Identification and Optimization	**6**
	Total	**24**

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	Practical	Tutorial	Credits	IE 1	IE 2	ETE	Total
2	-	-	2	20	30	50	100

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	6
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	6
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	6
4.	**Biological Treatment of Solid waste and landfill design** Biological Treatment of Solid and Hazardous Waste Composting; bioreactors;	6

	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	
Total		**24**

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 Kanti L.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

Pre-requisite: Basics of Electrical Engineering,

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,

1. the learners will be able to select battery for EV application and design battery pack
2. the learners will be able to estimate available energy and power of battery pack
3. The learners will be able to simulate charge discharge characteristics of a battery using equivalent circuit model
4. the learners will be able to estimate SOC and SOH of battery
5. the learners will be able to understand various methods of battery pack balancing
6. the learners will be able 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	6
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	5
3.	**State-of-Charge (SOC) Estimation and Battery Pack Balancing** Different approaches to estimating battery cell SOC, Kalman-filter method of SOC estimation: linear Kalman filter , 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**	6

	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 etc.	
	Total	**24**

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, Boryann Liaw (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

Pre-requisite: Thermodynamics; Fluid Mechanics; Heat Transfer; Elements of Electrical Engineering;

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:

1) To be able to determine the fundamental performance of characteristics of solar thermal, photovoltaic and wind energy systems
2) Enable the students to estimate the potential of solar and wind resources
3) To be able to understand the fundamentals of energy conversion from biomass, geothermal, tidal and ocean thermal energy conversion systems
4) To be able to determine the economic feasibility of renewable energy technologies

Detailed Syllabus:

Unit	Description	Duration h
1.	**Solar energy** Potential of Renewable energy sources (Flow & not stocks), Current scenario of worldwide installed capacity Solar- Earth Geometry for assessment of available solar radiation, Solar radiation estimation, instruments for measurement **Solar thermal collectors** – General description and characteristics: Flat plate collectors – Heat transfer processes – Short term and long-term collector performance. Solar concentrators – Aspects of Design, and performance evaluation. **Solar Photovoltaic Systems**– Working, Constructional details & Performance Assessment for Technmo-economic evaluation / feasibility	6
2.	**Wind energy -** Principles of wind energy conversion – Site selection considerations, Wind resource / energy potential measurement, wind electric generator components, Wind power plant design – *Aerodynamics and performance*, vertical vs. Horizontal axis design, and energy wheeling and banking concepts. Types of wind power conversion systems – Operation, maintenance and economics	6
3.	**Energy from biomass -** Sources of biomass – Different species, Conversion of biomass into fuels – Energy through fermentation – Pyrolysis, gasification and combustion – Aerobic and anaerobic bio-conversion, Properties of biomass Biogas plants – Types of plants – Design and operation – Properties and characteristics of biogas. Biogas / Producer Gas Technology, Engines - Constructional, Operational & Performance aspects	5
4	**Geothermal, Tidal and 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. Other plants**:** Fuel cell-based power plants, tidal and wave energy plant design	7
	Total	24

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

Pre-requisite:

Chemistry, Physics, Material Science, Metallurgy

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 engineering applications
3. Student will be able to evaluate and select materials for advanced engineering applications.

Detailed Syllabus:

Unit	Description	Duration, h
1	Advanced and exotic materials – ceramics and Plastics, Biomaterials, Aerogels, Superconductors, Carbon nano tubes	8
2	Mechanical, electrical, optical and magnetic properties of materials.	8
3	Smart materials, Piezoelectricity, Magnetostriction, smart polymers, Shape memory alloys	6
4	Introduction to nano, Nano-biomimicry, Synthesis of nanomaterials by physical and chemical methods, Synthesis of nanomaterials by biological methods, Characterizations of nanomaterials.	6
	Total	24

Text Books:

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

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 Properties of 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

Pre-requisite: Engineering Mathematics

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	6
2.	**Linear and non-Linear Programming** Simplex Methods, Elimination and iterative methods for one-dimensional minimization .	6
3.	**Simulation Modeling** Introduction, definition and types, limitations, various phases of modeling, Monte Carlo method, applications, advantages and limitations of simulation	6
4.	**Modern Methods of Optimization** Genetic algorithms, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization, etc.	6
	Total	24

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

Pre-requisite: Engineering Mathematics

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 h
1.	Introduction to Modelling and Simulation, Basic systems, Introduction and Types of Mathematical modelling, Basic building blocks Mechanical, Electrical, Thermal systems.	6
2.	Bond Graph Modelling of Dynamic Systems: Representation,Elements, Single,Two and multiports Causality, Application to basic Mechanical,Electrical and Electromechanical system	6
3.	Dynamic Response and System Transfer Function: Poles, Stability Block diagram/Signal flow diagram/State Space formulation and Frequency response	6
4.	Simulation and Simulation application Parameter Estimation, System Identification and Optimization	6
	Total	**24**

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

Pre-requisite: Engineering Mathematics, Physics,

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	6.
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,	6
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.	6
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.	6
	Total	24

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**

Pre-requisite:
Any Engineering Graduate

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	**04**
2.	Empathize Phase	**04**
3.	Define Phase	**04**
4.	Ideate Phase	**04**
5.	Prototype Phase	**04**
6.	Test Phase. One simple Product development using Design thinking tools	**04**
	Total	**24**

Reference Books:
1. Design Thinking methodology book by Emrah Yayici , Publisher Emrah Yayici, 2016
2. Designing for Growth: A design thinking toolkit for managers, Tim Ogilvie ,Columbia Business School Publishing

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**

Pre-requisite: Engineering Mathematics

Objectives:

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

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.	6
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,	6
3.	**Redundancy** Element redundancy, unit redundancy, standby redundancy- types of stand by redundancy, parallel components single redundancy, multiple redundancy. Markov analysis.	6
4.	**System reliability Analysis** Reliability apportionment, Reliability apportionment techniques – equal apportionment, AGREE, ARINC, feasibility of objectives apportionment.	6
	Total	**24**

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

Pre-requisite: . Basics of Programming

Objectives:

1. To acquire knowledge in Python and R programming
2. To develop Python programs with conditionals and loops and data structures
3. Acquire skills to apply data analysis methods to a problem

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, String Methods.	6
2.	**Lists:** Basic Operations, List slices,list methods,list and strings **Dictionaries:** looping and dictionaries, dictionaries & lists. **Tuples and Files :** reading and writing Functions: Definition, Call, Arguments ,Input output file handling.	6
3.	**Object Oriented Programming** features in Python: Classes, Objects, Inheritance,Errors and Exceptions: try, except and else statements, Exception Objects, Regular expressions.	6
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.	6
	Total	24

Text Books:

1. Allen B Downey, ―Think PYTHON‖, O'Rielly, ISBN: 13:978-93-5023-863-9, 4th Indian Reprint 2015
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

Pre-requisite:- None

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 the project.
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 life cycle.

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.	6
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, The structure of SRS, Ways of writing a SRS, Requirements elicitation & Analysis: Process, Requirements validation, Requirements management.	6
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	6
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	6
	Total	24

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. Rajib Mall, ―Fundamentals of Software Engineering‖, Prentice Hall India, ISBN-13: 978- 8120348981
3. Pankaj Jalote, ―An Integrated Approach to Software Engineering‖, Springer, ISBN 13: 9788173192715.
4. S K Chang, ―Handbook of Software Engineering and Knowledge Engineering‖, World Scientific, Vol I, II, ISBN: 978-981-02-4973-1
5. Tom Halt, ―Handbook of Software Engineering‖, Clanye International, 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

Pre-requisite:

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

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.To implement models such as support vector machines, kernel SVM, naive Bayes, decision tree 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)	6
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	6
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.	6
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	6

	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	**24**

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**

Pre-requisite: Programming Basics

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.	**6**
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.	**6**
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.	**6**
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	**6**
	Total	**24**

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:

1. J.C. Russ," The Image Processing Handbook", (5/e), CRC, 2006

2. R.C.Gonzalez & R.E. Woods; “Digital Image Processing with MATLAB”, Prentice Hall, 2003
3.W. K. Pratt, *Digital Image Processing*, John Wiley & Sons, 2006.
4.S. Ahmed, *Image Processing*, McGraw -Hill, 1994.
5.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

Pre-requisite:

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, Display etc.;	**6**
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 andworkflow, syntax, variables, operators, regular expressions, arrays, control flows, loops,functions, output redirections	**6**
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;	**6**
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, groupdeletc; Managing ownership and permission. **Process and PackageManagement:** Understanding package management,package management commands like rpm, yum, apt; Understanding Process hierarchy and identifying running processes; Log files. **Or** **Introduction to GIT and LaTEX:** LaTEX:Basic syntax, compiling and creating documents; Document structure including sections and paragraphs; Adding Images, Table ofcontents, 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.	**6**
	Total	**24**

Text Books: 1. Christine Bresnahan, Richard Blum ―Linux Essentials, Sybex, ISBN 9781119092063 2. Sumitava Das, Unix Concepts and Applications, Tata-McGraw Hill, ISBN 0-07-063546-3
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

Pre-requisite:
.Basic understanding of computer programming and related programming paradigms.

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. Micheal Blaha- Object-Oriented Modeling and Design with UML: Pearson Education India, ISBN-13: 978-0130159205

Reference Books:
2. Charles Ritcher - Designing Flexible Object-Oriented systems with UML. New Riders Publishing.
3. Jackson, Burd Thomson - Object Oriented Analysis & Design. Thomson Course Technology.
4. Mike O'Docherty - Object-Oriented Analysis and Design: using UML. Wiley Publication
5. Joseph Schmuilers - Teach Yourself UML in 24 Hours. Sams publishing.

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

Pre-requisite: Basics of Management, Basics of Finance

Objectives:

After Completing this course, student will have adequate background to understand and solve the problem involving :Outline the principles followed in carrying out a project.

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 diverse teams.
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	6
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.	6
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	6
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.	6
	Total	24

Text Books:

1. Project Management Institute A Guide to the Project Management Bodyof Knowledge PMBOK Guide (Sixth Edition), Sept 2017.
2. James C.Van Horne, Fundamentals of Financial Management, Person Education 2004.
3. Khanna, R.B.,Project Management, PHI 2011.

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, Jonathan Duchac.
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

Pre-requisite:

1. Environmental study, Types of pollution

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.	6
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.	6
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.	6

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	**6**
	Total	**24**

Text Books:

1. Green Technologies, Soli J. Arceivala, Mc Graw Hill Education.

Reference Books

1. Green Technologies and Environmental Sustainability edited by Ritu Singh, Sanjeev Kumar
2. http://cpcbenvis.nic.in/greentechnology.html

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

Pre-requisite: None

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.	6
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.	6
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.	6
4.	**Arbitration:** Comparison of Actions and Laws - Agreements, subject matter-Violations- Appointment of Arbitrators-Conditions of Arbitrations-Powers and duties of	6
	Total	24

Text Books:

1. Civil Engineering Contracts and Estimates - B.S.Patil – Universities Press- 2006 Edition,reprinted in 2009.
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. 30 Edition

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

Pre-requisite: TQM & MIS at UG Level , Awareness of Quality Construction Aspects

Objectives:

1. To **understand** the need of QM in construction and **apply** necessary tools to achieve
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 in construction
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.	**6**
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.	**6**
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.	**6**
4.	**A) Six Sigma** 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 Six Sigma** i) RCC Work in building (ii) Assessment of overall construction process from concept to completion of a construction project.	**6**
	Total	**24**

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 – Mantri Publications
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**	**IE 1**	**IE 2**	**ETE**	**Total**
2	**2**	**2**	**20**	**--**	**30**	**50**

Pre-requisite: SACM

Outcomes:

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

1. Acquire a sound knowledge of principles of Operation Research and its applications.
2. Apply forecasting methods / principles of scheduling, sequencing, maintenance planning
3. 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**
1.	Use of Operations Research in Civil 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.	**6**
2.	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.	**6**
3.	a) Transportation Model and its variants, b) Assignment Model and its variants. c) Decision theory.	**6**
4.	(a) Queuing Theory, Simulation. (b) Sequencing model – n jobs through 2, 3 and M machines. (c) Replacement models. (d) Games Theory.	**6**
	Total	**24**

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. H.M.Wagner, Principles of Operations Management , Prentice Hall.
4. Hira and Gupta, Operation Research, S.Chand Publishers
5. Ravindra, Philip &Solberg, Operations Research: Principles and Practice, Wiley,India

Program:	M. Tech. (Information Technology)				Semester : I	
Course :	Business Analytics				Code : MEIT1601A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	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 h
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.	**6**
2.	**Analytics Techniques** Optimization techniques: Linear Programming, Goal Programming, Integer Programming, Non –linear programming, Predictive modeling :- regression, multiple linear regression for predictive analysis, logistic regression, linear discriminant analysis, Data Mining: Introduction to supervised and unsupervised learning, clustering	**6**
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	**6**
4.	**Data analytics tools** Data Visualization using Tableau/Python/R/SQL. Case study.	**6**
	Total	**24**

Text Books:

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

Reference Books:

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

Program:	M. Tech. (Information Technology)				Semester : I	
Course :	R Programming				Code : MEIT1601B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	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. Understand 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 h
1.	**Getting Started with R Programming** Introduction to the R-Studio, user-interface, Basic commands, Data Structures in R, Reading data into R, Subsetting	6
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	6
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	6
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	6
	Total	24

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. (Information Technology)			Semester : I		
Course :	Cost Management of Engineering Project			Code : MEIT1601C		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	-	30	50

Pre-requisite:
1. Software Engineering, 2. Project Management

Objectives:
1. To provide the parties concerned with a most favorable financial outcome to the project.
2. Identifying "best value" project option selection and developing realistic budgets.

Outcomes:
After learning the course, the students should be able to:
1. Prepare favorable financial outcome to the project.

Detailed Syllabus:

Unit	Description	Duration h
1.	**Introduction and Purpose of Project Cost Management** Client, Engineering consultant supporting Client in Development Phase, Engineering (Managing) Contractor carrying out EPCM role for project implementation, Consultant acting as PMC for Client, Material Suppliers, Construction / Service Contractors, External Finance Provider	**6**
2.	**Core Project Cost Management Issues** Project Concept & Feasibility, Project Development & Definition, Project Implementation, Project Commissioning & Financial Close out	**6**
3.	**Estimating and Project Financing** Estimate Categories, Estimate Quality, Project Schedule influence on estimated cost, Estimate Scope, Study / Development Estimates, Estimates for provision of advanced funding, Estimate quality required for project authorization, Estimating techniques, Location factors, Escalation ,Currency fluctuations, Contingency, Cash flow Project Financing: Internal financing, Financing of project development works, External financing, Banks & Venture Funds, Government grants and loans, Contractors, Suppliers, Customers	**6**
4.	**Vulnerable Projects** Mega-projects (Projects with value >€2Bn), Retrofit projects (Modifications and extensions to existing facilities), New Technology projects, Sub-surface works, Projects in emerging markets (e.g. E Europe, Asia), Projects in remote locations, Projects requiring significant regulatory validation (e.g. Pharmaceutical, Nuclear), Contaminated Demolition, Fast Track Projects	**6**
	Total	**24**

Text Books:
1. Kenneth K. Humphreys, Lloyd M. English, "Project and cost engineer's handbook", third edition, Ace International, Marcel Dekkar Inc., New York Basel.

Reference Books:
1. Kenneth K. Humphreys, Lloyd M. English, "Project and cost engineer's handbook", third edition, Ace International, Marcel Dekkar Inc., New York Basel.

Program:	M. Tech. (Information Technology)			Semester :	II	
Course :	Cryptography			Code :	MEIT2602A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	-	30	50

Pre-requisite:
1. Basic Mathematics
2. Basic Computer Network.

1. To understand computer, network and information security.
2. To study operating system security and malwares.
3. To study security issues in internet protocols.
4. To study network defense tools.

Outcomes:
After learning the course, the students should be able to:
1. Understand modern concepts related to cryptography and cryptanalysis
2. Analyze and use methods for cryptography and reflect about limits and applicability of these methods
3. Learn details and design philosophy of modern symmetric and public key systems
4. Learn uses and limitations of the various categories of cryptographic algorithms

Detailed Syllabus:

Unit	Description	Duration h
1.	**Introduction:** Computer Security Concepts, Terminology, OSI Security Architecture, Elements Of Information Security, Security Policy, Types of Security attacks , Security Goals and services, Modular Arithmetic, GCD, Euclidean Algorithm, Fermat's Little Theorem, Euler Totient Function, Extended Euclidean Algorithm, Chinese Remainder Theorem.	6
2.	**Classical Encryption Techniques:** Symmetric Cipher Model, Encryption Methods, Classical Encryption Techniques, Substitution Ciphers, Transposition Ciphers, one-time pad, Cryptanalysis, Block Ciphers, Stream Ciphers	6
3.	**Private-key Encryption:** Block Cipher Principles, Data Encryption Standard (DES), Triple DES, Advanced Encryption Standard (AES), RC5, International Data Encryption Algorithm (IDEA), Differential and Linear cryptanalysis	6
4.	**Public-key cryptosystems:** Public-Key Cryptography, Key Management, Key Distribution, RSA, Timing Attack, Diffie Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography [ECC]	6
	Total	24

Text Books:
1. William Stallings, Computer Security: Principles and Practices, Pearson 6th Ed, ISBN: 978-0-13-335469-0
2. V. K. Pachghare, "Cryptography and Information Security", PHI Learning 3rd edition
3. Jonathan Katz, Yehuda Lindell, "Introduction to Modern Cryptography", CRC press

Reference Books:
1. Oded Goldreich, Foundations of Cryptography Basic Tools, Cambridge University Press.
2. Nina Godbole, Information Systems Security, Wiley India Pvt. Ltd, ISBN -978-81-265-1692-6

Program:	M. Tech. (Information Technology)			Semester : II		
Course :	Cloud Computing and Security			Code : MEIT2602B		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	-	30	50

Pre-requisite:
1. Operating Systems
2. Fundamentals of Computer Networks.

Objectives:
1. To become familiar with Cloud Computing and its ecosystem.
2. To learn basics of virtualization and its importance.
3. To give technical overview of Cloud Programming and Services.
4. To understand security issues in cloud computing.

Outcomes:
After learning the course, the students should be able to:
1. To understand the need of Cloud based solutions.
2. To understand Security Mechanisms and issues in various Cloud Applications
3. To explore effective techniques to program Cloud Systems.
4. To understand current challenges and trade-offs in Cloud Computing..

Detailed Syllabus:

Unit	Description	Duration h
1.	**Fundamentals of cloud computing:** Origins and Influences, Basic Concepts and Terminology, Goals and Benefits, Risks and Challenges, Roles and Boundaries, Cloud Characteristics, Cloud Delivery Models, Cloud Deployment Models, Federated Cloud/Intercloud, Types of Clouds. Cloud-Enabling Technology: Broadband Networks and Internet Architecture, Data Center Technology, Virtualization Technology, Web Technology, Multitenant Technology, Service Technology.	6
2.	**Virtualization and common standards in cloud computing:** Implementation Levels of Virtualization, Virtualization Structures/Tools and Mechanisms, Types of Hypervisors, Virtualization of CPU, Memory, and I/O Devices, Virtual Clusters and Resource Management, Virtualization for Data-Center Automation. Common Standards: The Open Cloud Consortium, Open Virtualization Format, Standards for Application Developers: Browsers (Ajax), Data (XML, JSON), Solution Stacks (LAMP and LAPP),Syndication (Atom, Atom Publishing Protocol, and RSS), Standards for Security	6
3.	**Cloud programming, environments and applications: :** Features of Cloud and Grid Platforms, Programming Support of Google App Engine, Programming on Amazon AWS and Microsoft Azure, Emerging Cloud Software Environments, Understanding Core OpenStack Ecosystem. Applications: Moving application to cloud, Microsoft Cloud Services, Google Cloud Applications, Amazon Cloud Services, Cloud Applications (Social Networking, E-mail, Office Services, Google Apps, Customer Relationship Management).	6
4.	**Cloud security and issues:** Basic Terms and Concepts, Threat Agents, Cloud Security Threats and Attacks, Additional Considerations, Cloud Security Mechanisms: Encryption, Hashing, Digital Signature, Public Key Infrastructure (PKI), Identity and Access Management (IAM), Single Sign-On (SSO), Hardened Virtual Server Images. Cloud Issues: Stability, Partner Quality, Longevity, Business Continuity, Service-Level Agreements, Agreeing on the Service of Clouds, Solving Problems, Quality of Service, Regulatory Issues and Accountability.	6
	Total	24

Text Books:

1. Jack J. Dongarra, Kai Hwang, Geoffrey C. Fox, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Elsevier, ISBN :9789381269237, 9381269238, 1st Edition.
2. Thomas Erl, Zaigham Mahmood and Ricardo Puttini, Cloud Computing: Concepts, Technology & Architecture, Pearson, ISBN :978 9332535923, 9332535922, 1 st Edition.

Reference Books:

1. Srinivasan, J. Suresh, Cloud Computing: A practical approach for learning and implementation, Pearson, ISBN :9788131776513.
2. Brian J.S. Chee and Curtis Franklin, Jr., Cloud Computing: Technologies and Strategies of the Ubiquitous Data Center, CRC Press, ISBN :9781439806128.
3. Kris Jamsa, Cloud Computing: Saas, Paas, Iaas, Virtualization, Business Models, Mobile, Security, and More, Jones and Bartlett, ISBN :9789380853772.
4. John W. Ritting house, James F. Ransome, Cloud Computing Implementation, Management, and Security, CRC Press, ISBN : 978 1439806807, 1439806802.
5. Karl Matthias, Sean P. Kane, Docker: Up and Running, OReilly, ISBN:9781491917572, 1491917571.

Program:	M. Tech. (Information Technology)				Semester : II	
Course :	Bitcoin : Fundamentals of Crypto Currencies				Code : MEIT2602C	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	-	30	50

Pre-requisite:
1. Basic of Cryptography
2. Basic of Information and Cyber security.

Objectives:
1. To understand the basic concepts behind Cryptography and Crypto currency.
2. To understand the different Consensus approaches for Bit coin.
3. To understand the concepts of blockchain technology.
4. To understand the Mechanics of bit coin.

Outcomes:
After learning the course, the students should be able to:
1. Apply Cryptography concepts to Currency (real time) problem solving.
2. Learn and apply different consensus mechanisms for real time projects based on digital currency.
3. Analyze block chain model come from a different case studies.

Detailed Syllabus:

Unit	Description	Duration h
1.	**Basics** Fundamentals of Crypto currencies : Nodes, Transaction , Wallets, Coin Mining ,Basics of Trading Exchanges ,Market Tradability Crypto Trading Strategies, Blockchain: Nodes, P2P , Ledger ,Consensus Methods Genesis Block	6
2.	**How to Store and Use Bit coins** How to Store and Use Bit coins, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services, Transaction Fees, Currency Exchange Market	6
3.	**Cryptography:** Cryptographic Hash Functions: Hashing and SHA 256, Digital Signatures, Public Keys , Private Keys, A Simple Crypto currency	6
4.	**Mechanics of Bit coin** Bit coin Transactions, Bit coin Scripts, Applications of Bit coin Scripts, Bit coin Blocks, The Bit coin Network, How Bit coin Achieves Decentralization, Centralization vs. Decentralization, Distributed Consensus : Consensus without Identity, The Block chain Incentives, Miners and Mining :Proof of Work ,Limitations & Improvements.	6
	Total	24

Text Books:

1. Martin Quest, "Block chain Dynamics: A Quick Beginner's Guide on Understanding the Foundations of Bit coin and Other Crypto currencies", Create Space Independent Publishing Platform, 15-May-2018
2. Daniel Drescher, "Block chain Basics", A Non -Technical Introduction in 25 Steps.

Reference Books:

1. Bikramaditya Singhal, Gautam Dhameja, Priyansu Sekhar Panda, "Beginning Block chain A Beginner's Guide to Building Block chain Solutions", 2018
2. 2. Chris Dannen , "Introducing Ethereum and Solidity", Foundations of Crypto currency and Block chain Programming for Beginners

Annexure-II

Audit Courses

Program: M.Tech					**Semester:** I and II	
Course : Audit Courses (Semester I and II)					**Code:**	1961 2962
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
1	1	--	--	--	--	--

Guidelines:

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

Program:	M.Tech				Semester : I	
Course :	Constitution of India				Code : M_1961A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
1	1	-	--	--	--	--

Objectives:

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

Outcomes:

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

1. Work cohesively without violating the rules and regulations of the constitution
2. Understanding and application of E-governance for suitable projects

Detailed Syllabus:

Unit	Description	Duration h
1.	Introduction to Constitution of India; Salient Features of the Constitution; Fundamental Rights and Fundamental Duties; Directive Principles of State Policy Role of Public Sector Undertakings in economic development; Need for Reformed Engineering Serving at the Union and State level	6
2.	E-Governance and Role of engineers in E-Governance; Finance Commission and Centre-State Relations; Role of I.T. professionals in Judiciary; Cyber laws in India	6
	Total	12

Text Books:

1. Brij Kishore Sharma: An Introduction to the Constitution of India, Eighth Edition. PHI Learning, 2011
2. C.S.Prabhu: E-Governance, Concepts and Case Studies

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

Program:	M.Tech.				Semester :	I
Course :	Value Education				Code :	M_1961B
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	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:

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

Detailed Syllabus:

Unit	Description	Duration h
1	Why Human Relations are so important? Understanding Behavior, 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" Robart Lussier, 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.			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 efficiency

Detailed Syllabus:

Unit	Description	Duration h
3.	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 Yogabhyasi Mandal, Nagpur

Reference Books:

1. Swami Vivekananda, Rajayoga or conquering the Internal Nature, Advaita Ashrama (Publication Department), Kolkata
2. Wendelin Küpers, 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.**				**Semester: II**	
Course:	**Team Building & Leadership**				**Code: M_2962A**	
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE 1**	**IE 2**	**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. Ikujiro Nonaka, The Knowledge-Creating Company
3. Michael West, The Secrets of Successful Team Management, Chap. 2, "Self-Management," pgs. 32-61

Program: M.Tech				**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 healthy mind in a healthy body thus improving social health also
2. Improve efficiency

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. Introduction Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	**6**
2	key skills are needed when writing a 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. Day 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's book .
3. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Program:	M.Tech.			Semester : II		
Course :	Disaster Management			Code : M_2962C		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	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, Navale Pandharinath, Earth and Atmospheric Disaster Management : Nature and Manmade, B S Publication
6. Shailesh Shukla, Shamna Hussain, 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.

VISION AND MISSION OF ELECTRONICS AND TELECOMMUNICATION

Vision:

- To serve the society by creating competent **Electronics and Telecommunication** engineers with value added quality education.

Mission:

- To produce competent and cultured **Electronics and Telecommunication** engineers through quality education by imparting attitude, knowledge, skills, project based learning using well defined teaching learning process and excellent learning facilities to serve the needs of society.

Programme outcomes:

1. An ability to independently carry out research /investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Programme Specific Outcomes:

4. Acquire competency in areas of VLSI and Embedded Systems, Design, Testing, Verification and prototype development focusing on applications.
5. Integrate multiple sub-systems to develop System on Chip, optimize its performance and excel in industry sectors related to VLSI / Embedded domain.

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E&TC Engineering.

Mechanical Engineering.

Features of PhD Research Centers

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

– Colin Powell

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