COURSE STRUCTURE
AND
DETAILED SYLLABUS
R18 PG

DEPARTMENT OF

ELECTRONICS AND COMMUNICATION ENGINEERING

DEPARTMENT OF ECE

I Semester

S. No.	Core or Elective	Course Code	Course Name	L	T	P	IM	EM	CR
1	Core 1	1854101	Digital System Design	3	0	0	40	60	3
2	Core 2	1854102	Digital Communication Techniques	3	0	0	40	60	3
3	PE I	1854103 1854104 1854105	1.Analog & Digital CMOS VLSI Design 2.Low power VLSI 3.SoC Design	3	0	0	40	60	3
4	PE II	1854106 1854107 1854108	1.Digital Image & Video Processing 2. Wireless & Mobile Communications 3. Advanced Communication Networks	3	0	0	40	60	3
5		1800109	Research Methodology & IPR	2	0	0	40	60	2
6	Core	1854110	DSD Lab	0	0	4	50	50	2
7	Core	1854111	DCT Lab	0	0	4	50	50	2
8	Audit Course	1870A02	Disaster Management	2	0	0	40	0	0
Total:				16	0	8	300	400	18

R 18-PG SYLLABUS

II Semester

S. No.	Core or Elective	Course Code	Course Name	L	T	P	IM	EM	CR
1	Core 3	1854201	Microcontrollers & Programmable DSP Processors	3	0	0	40	60	3
2	Core 4	1854202	Advanced DSP	3	0	0	40	60	3
3	PE III	1854203 1854204 1854205	1.Advanced Computer Architecture 2.IOT & Applications 3.VLSI Signal Processing	3	0	0	40	60	3
4	PE IV	1854206 1854207 1854208	1.Detection & Estimation Theory 2.Optical Networks 3.Biomedical Signal Processing	3	0	0	40	60	3
5	Core	1854209	Mini Project with Seminar	0	0	4	100	0	2
6	Core	1854210	Microcontrollers and Programmable DSP Processors Lab	0	0	4	50	50	2
7	Core	1854211	Advanced DSP Lab	0	0	4	50	50	2
8	Audit Course	1870A01	English for Research paper writing	2	0	0	40	0	0
Total:				14	0	12	360	340	18

III Semester

S. No.	Core or Elective	Course Code	Course Name	L	T	P	IM	EM	CR
1	PE V	1854301 1854302 1854303	1.Microcomputer System Design 2. Joint Time Frequency Analysis & MRA 3. Pattern recognition & Machine learning	3	0	0	40	60	3
2	OE	1871304 1871305 1871306 1871307 1871308 1871309	1.Business Analytics 2.Industrial Safety 3.Operations Research 4.Cost Management of Engineering Projects 5.Composite Materials 6.Waste to Energy	3	0	0	40	60	3
3	Major Project	1854310	Dissertation Phase I	0	0	20	100	-	10
Total:				6	0	20	180	120	16

IV Semester

S. No.	Core or Elective	Course Code	Course Name	L	T	P	IM	EM	CR
1	Major Project	1854401	Dissertation Phase II	0	0	32	50	50	16
Total:				0	0	32	50	50	16

Course Title	Digital System Design				M.Tech. I Sem			
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1854101	Core 1	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs			

Course Objectives:

- To analyze and design combinational and sequential logic circuits.
- Troubleshooting faults regarding Digital Systems.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Design sequential circuits using ROMs and PLAs.
CO 2	Diagnosis of faults in Combinational circuits.
CO 3	Generate patterns for testing faults.
CO 4	Design Testable PLA.
CO 5	Design Asynchronous Sequential Machine.

UNIT I

Design of Digital Systems: ASM charts, Hardware description language and control sequence method, design of sequential circuits using ROMs and PLAs, sequential circuit design using CPLD, FPGAs.

UNIT II

Fault Modeling & Test Generation : Fault classes and models – Stuck at faults, bridging faults, transition and intermittent faults, Fault diagnosis of Combinational circuits by conventional methods- Path Sensitization technique, Boolean difference method, Kohavi algorithm.

UNIT III

Test Pattern Generation & Fault Diagnosis: D – algorithm, PODEM, Random testing, Signature Analysis and testing for bridging faults, Design of fault detection.

UNIT IV

Programmable Logic Arrays: Design using PLAs, PLA minimization and PLA folding

Fault models, Test generation and Testable PLA design.

UNIT V

Asynchronous Sequential Machine: Fundamental mode model, flow table, state reduction, minimal closed covers, races, cycles and hazards.

Text Books:

1. Z. Kohavi – "Switching & finite Automata Theory" (TMH)
2. N. N. Biswas – "Logic Design Theory" (PHI)
3. Nolman Balabanian, Bradley Calson – "Digital Logic Design Principles" – Wily Student Edition 2004.
4. Stephan Eggersglüß and Rolf Drechsler, "High Quality Test Pattern Generation and Boolean Satisfiability", Springer; 2012th edition.

Reference Books:

1. Charles H. Roth Jr. – "Fundamentals of Logic Design".
2. Frederick. J. Hill & Peterson – "Computer Aided Logic Design" – Wiley 4th Edition.
3. Barry Wilkinson, "Digital System Design", Prentice Hall; 2nd edition.
4. Zainalabedin Navabi, "Digital System Test and Testable Design", Springer US.

Course Title	Digital Communication Techniques				M.Tech. I Sem			
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1854102	Core 2	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	30	70	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs			

Course Objectives:

- To Understand basic components of digital communication systems.
- To Design optimum receivers for digital modulation techniques.
- To Analyze the error performance of digital modulation techniques.
- To Design digital communication systems under given power, spectral and error performance constrains.

Course Outcomes: After completion of the course the students are able to

CO 1	**Understand** the orthogonalization and characteristics of random processes
CO 2	**Analyze** the receivers and equalizers.
CO 3	**Analyze** various Digital Modulation Schemes.
CO 4	**Analyze** various synchronization methods
CO 5	**Describe** Multicarrier Systems

UNIT I

Deterministic and Random Signal Analysis

Bandpass and Lowpass Signal Representation , Signal Space Representation of Waveforms- Vector Space Concepts, Signal Space Concepts, Orthogonal Expansions of Signals- Gram-Schmidt Procedure, Some Useful Random Variables , Bounds on Tail Probabilities, Limit Theorems for Sums of Random Variables , Random Processes -Wide-Sense Stationary Random Processes, Cyclostationary Random Processes, Bandpass and Lowpass Random Processes

UNIT II

Digital Communication Through Band-Limited Channels

Design of Band-Limited Signals for No Intersymbol Interference—The Nyquist Criterion, Design of Band-Limited Signals with Controlled ISI—Partial-Response Signals, Data Detection for Controlled ISI, Signal Design for Channels with Distortion, Optimum Receiver for Channels with ISI and AWGN - Optimum Maximum-Likelihood Receiver , Linear Equalization - Peak Distortion Criterion, Mean-Square-Error(MSE) Criterion, Performance Characteristics of the MSE Equalizer , Fractionally Spaced Equalizers, Baseband and Pass band Linear Equalizers, Decision-Feedback Equalization -Coefficient Optimization , Performance Characteristics of DFE , Predictive Decision-Feedback Equalizer.

UNIT III

Digital Modulation Schemes:

Introduction, Geometric Representation of Signals, Conversion of the Continuous AWGN Channel into a Vector Channel, Optimum Receivers Using Coherent Detection, Probability of Error, Phase-Shift Keying Techniques Using Coherent Detection, *M*-ary Quadrature Amplitude Modulation, Frequency-Shift Keying Techniques Using Coherent Detection ,

Comparison of *M*-ary PSK and *M*-ary FSK from an Information-Theoretic Viewpoint, Detection of Signals with Unknown Phase, Noncoherent Orthogonal Modulation Techniques, Binary Frequency-Shift Keying Using Noncoherent Detection, Differential Phase-Shift Keying, BER Comparison of Signaling Schemes over AWGN Channels.

UNIT IV

Synchronization:

Synchronization Defined, Costs versus Benefits, Receiver Synchronization- Frequency and Phase Synchronization, Symbol Synchronization, Discrete Symbol Modulations, Synchronization with Continuous-Phase Modulations (CPM), Frame Synchronization

UNIT V

Multichannel and Multicarrier Systems

Multichannel Digital Communications in AWGN Channels- Binary Signals, M-ary Orthogonal Signals Multicarrier Communications - Single-Carrier Versus Multicarrier Modulation , Capacity of a Nonideal Linear Filter Channel , Orthogonal Frequency Division Multiplexing (OFDM), Modulation and Demodulation in an OFDM System , An FFT Algorithm Implementation of an OFDM System, Spectral Characteristics of Multicarrier Signals , Bit and Power Allocation in Multicarrier Modulation, Peak-to-Average Ratio in Multicarrier Modulation, Channel Coding Considerations in Multicarrier Modulation

Text Books:

1. J.G. Proakis and Masoud Salehi, Digital Communications, McGraw Hill, 2000.
2. Bernerd Sklar, " Digital Communications- Fundamentals & Applications, "Prentice Hall, 2001.
3. Simon S Haykin, "Digital Communications Systems", Wiley, 2013.
4. Ahmad R S Bahai ,Burton R Saltzberg ,Mustafa Ergen, "Multi-carrier Digital Communications: Theory and Applications of OFDM." Springer Publications.

Reference Books:

1. J.S.Chitode, "Digital Communication", Technical Publications.
2. Edward. A. Lee and David. G. Messerschmitt, "Digital Communication", Allied Publishers (second edition).
3. J Marvin.K.Simon, Sami. M. Hinedi and William. C. Lindsey, "Digital Communication Techniques", PHI.
4. William Feller, "An introduction to Probability Theory and its applications", Vol 11, Wiley 2000.

Course Title	Analog and Digital CMOS VLSI Design				M.Tech. I Sem		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**	
1854103	**PE I**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exams**	**Total**
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					**End Exam Duration: 3Hrs**			

Course Objectives:

- To understand Optimization and simulation of analog and digital circuits using CMOS.
- To understand the concepts of Analog MOS devices and current mirror circuits.

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

CO 1	Analyze, design, optimize and simulate analog and digital circuits using CMOS
CO 2	constrained by the design metrics
CO 3	Connect the individual gates to form the building blocks of a system.
CO 4	Use EDA tools like Cadence, Mentor Graphics and other open source software tools like Ngspice

Digital CMOS Design:

Unit I

Review: Basic MOS structure and its static behaviour, Dynamic Behavior, Stick diagram and Layout, Wire delay models. Inverter: Static CMOS inverter, Switching threshold and noise margin concepts and their evaluation, Power consumption.

Unit II

Physical design flow: Floor planning, Placement, Routing, CTS, Power analysis. Combinational logic: Static CMOS design, Complementary CMOS, Ratioed logic, Pass transistor logic, Dynamic logic, Speed and power dissipation in dynamic logic, Cascading dynamic gates.

Unit III

Sequential logic: Static latches and registers, Bi-stability principle, MUX based latches, Static SR flip-flops, Master-slave edge-triggered register, Dynamic latches and registers, Concept of pipelining, Pulse registers, Non-bistable sequential circuit.

Analog CMOS Design:

Unit IV

Single Stage Amplifier: CS stage with resistance load, Diode connected load, Current source load, CS stage with source degeneration, Common gate stage, CG Stage With Biasing Source follower, Source Follower With Biasing.

Unit V

Passive and active current mirrors: Basic current mirrors, Cascode Stage, Cascode as a Current Source, Cascode as an Amplifier , Active current mirrors, Bipolar Current Mirror, MOS Current Mirror.

Text Books:

1. J P Rabaey, A P Chandrakasan, B Nikolic, "Digital Integrated circuits: A design perspective", Prentice Hall electronics and VLSI series, 2nd Edition.
2. Baker, Li, Boyce, "CMOS Circuit Design, Layout, and Simulation", Wiley, 2nd Edition.
3. BehzadRazavi , "Design of Analog CMOS Integrated Circuits", TMH, 2007.
4. Phillip E. Allen and Douglas R. Holberg, "CMOS Analog Circuit Design", Oxford, 3rd Edition.

References:

1. R J Baker, "CMOS circuit Design, Layout and Simulation", IEEE Inc., 2008.
2. Kang, S. and Leblebici, Y., "CMOS Digital Integrated Circuits, Analysis and Design" TMH, 3rdEdition.
3. Pucknell, D.A. and Eshraghian, K., "Basic VLSI Design", PHI, 3rd Edition.
4. Kenneth Martin Chan Carusone and David Johns, "Analog Integrated Circuit Design", Wiley; Second edition.

Course Title	Low Power VLSI Design				M.Tech. I Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1854104	PE I	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs		

Course Objectives:

- To identify the sources of power dissipation in digital IC systems & understand the impact of power on system performance and reliability.
- To understand leakage sources and reduction techniques

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

CO 1	Understand leakage sources and reduction techniques.
CO 2	Characterize and model power consumption & understand the basic analysis methods.
CO 3	Identify the sources of power dissipation in digital IC systems & understand the impact of power on system performance and reliability.

UNIT-I

Technology & Circuit Design Levels: Sources of power dissipation in digital ICs, degree of freedom, recurring themes in low-power, emerging low power approaches, dynamic dissipation in CMOS, effects of Vdd & Vt on speed, constraints on Vt reduction, transistor sizing & optimal gate oxide thickness, impact of technology scaling, technology innovations.

UNIT- II

Low Power Circuit Techniques: Power consumption in circuits, flip-flops & latches, high capacitance nodes, energy recovery, reversible pipelines, high performance approaches.

UNIT -III

Low Power Clock Distribution: Power dissipation in clock distribution, single driver Versus distributed buffers, buffers & device sizing under process variations, zero skew Vs. Tolerable skew, chip & package co-design of clock network.

UNIT- IV

Logic Synthesis for Low Power estimation techniques: Power minimization techniques, low power arithmetic components- circuit design styles, adders, multipliers.

UNIT- V

Low Power Memory Design: Sources & reduction of power dissipation in memory subsystem, sources of power dissipation in DRAM & SRAM, low power DRAM circuits, low power SRAM circuits.

Text Books:

1. P. Rashinkar, Paterson and L. Singh, “Low Power Design Methodologies”, KluwerAcademic, 2002
2. Kaushik Roy, Sharat Prasad, “Low power CMOS VLSI circuit design”, John WileysonsInc.,2000.
3. J.B.Kulo and J.H Lou, “Low voltage CMOS VLSI Circuits”, Wiley, 1999.
4. Sung-Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits –Analysis and Design, TMH,2011.

References:

1. A. P. Chandrasekaran and R. W. Broadersen, “Low power digital CMOS design”, Kluwer,1995
2. Gary Yeap, “Practical low power digital VLSI design”, Kluwer, 1998.
3. Kiat-Seng Yeo, Kaushik Roy, “Low-Voltage, Low-Power VLSI Subsystems”, TMH Professional Engineering.
4. Ming-BO Lin, “Introduction to VLSI Systems: A Logic, Circuit and System Perspective” CRC Press,2011

Course Title	SOC Design				M.Tech. I Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1854105	PE I	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs		

Course Objectives:

- To Design SoC based system for engineering applications.
- To Realize impact of SoC on electronic design philosophy and Macro-electronics therebyincline towards entrepreneurship & skill development.
- To Simulate Low power FPGA, configurable systems.

Course Outcomes: At the end of this course, students will be able to	
CO 1	Identify a given problem in the framework of SoC based design approaches.
CO 2	Design SoC based system for engineering applications.
CO 3	Realize impact of SoC on electronic design philosophy and Macro-electronics thereby incline towards entrepreneurship & skill development.
CO 4	Simulate Low power FPGA, configurable systems.
CO 5	Synthesize Technology independent and technology dependent approaches.

UNIT- I

ASIC : Overview of ASIC types, design strategies, CISC, RISC and NISC approaches for SOC architectural issues and its impact on SoC design methodologies, Application Specific Instruction Processor (ASIP) concepts.

UNIT- II

NISC Control Words methodology, NISC Applications and Advantages, Architecture Description Languages (ADL) for design and verification of Application Specific Instructionset Processors (ASIP), No-Instruction-Set-computer (NISC)- design flow, modeling NISC architectures and systems.

UNIT- III

Simulation: Different simulation modes, behavioural, functional, static timing, gate level, switch level, transistor/circuit simulation, design of verification vectors, Low power FPGA, configurable systems, SoC related modeling of data path design and control logic, Minimization of interconnects impact, clock tree design issues.

UNIT- IV

Low power SoC design / Digital system, Design synergy, Low power system perspective-power gating, clock gating, adaptive voltage scaling (AVS), Static voltage scaling, Dynamic clock frequency and voltage scaling (DCFS), building block optimization, building block memory, power down techniques, power consumption verification.

UNIT- V

Synthesis: Role and Concept of graph theory and its relevance to synthesizable constructs, Walks, trails paths, connectivity, components, mapping/visualization, nodal and admittance

graph. Technology independent and technology dependent approaches for synthesis, optimization constraints, Synthesis report analysis.

Text Books:

1. Hubert Kaeslin, “Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication”, Cambridge University Press, 2008.
2. B. Al Hashimi, “System on chip-Next generation electronics”, The IET, 2006
3. Rochit Rajsuman, “System-on- a-chip: Design and test”, Advantest America R & D Center,2000
4. P Mishra and N Dutt, “Processor Description Languages”, Morgan Kaufmann, 2008

References:

1. Michael J. Flynn and Wayne Luk, “Computer System Design: System-on-Chip”. Wiley,2011
2. Richard S. Sandige, “Modern Digital Design”, MGH, International Editions, 1990
3. Charles H. Roth, “Fundamentals of Logic Design”, 5th Edition. Cengage Learning, 2010.
4. B. Al Hashimi, “System on chip-Next generation electronics”, The IET, 2006

Course Title	Digital Image and Video Processing				M.Tech. I Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1854106	PE II	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs		

Course Objectives:

- To provide an introduction to the basic concepts and techniques used in digital image and video processing.
- To give an understanding of the two-dimensional sampling and quantization
- To study Edge detection and Image Enhancement Algorithms
- To Understand techniques for video sampling and motion estimation
- To Study techniques for image and video compression and object recognition

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

CO 1	Define various image and video processing parameters
CO 2	Explain image filtering, segmentation, restoration and compression
CO 3	Compare different Color models, enhancement techniques, motion estimation and image restoration techniques
CO 4	Apply the concepts of image and video processing techniques in various applications.
CO 5	Analyze mathematical operations, coding, filtering and motion estimation methods in image and video processing.

UNIT I

Fundamentals of Image Processing: Digital image fundamentals, Applications of image processing, Image Sampling and Quantization, relationship between pixels.

Image Transforms: General approach for operating in the linear transform domain, 2-D DFT and Properties, Walsh transform, Hadamard Transform, Discrete cosine Transform, Haar transform, KL Transform or Hotelling transform.

UNIT II

Image Enhancement: Spatial domain methods: Spatial domain methods: Point processing, Histogram processing, Fundamentals of spatial filtering, smoothing spatial filters, sharpening spatial filters.

Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Homomorphic filtering, LOG filters.

Colour image processing: Colour fundamentals, colour models, Pseudo color image processing.

UNIT III

Image Segmentation: Point, Line and Edge detection, Edge linking and boundary detection, Thresholding, Region based segmentation – Region growing, Region splitting and merging. Region Based segmentation.

Image Restoration: Degradation model, Noise models, Restoration in the presence of noise only – spatial filtering, Periodic noise reduction by frequency domain filtering, linear position-Invariant degradation, restoration using inverse filtering, Wiener filtering, Constrained Least Squares filtering.

UNIT IV

Image Compression: Redundancies in images, Fidelity criteria, Image compression models, Error free compression – Variable length coding, Huffman coding, Arithmetic coding, LZW coding, Bit-plane coding, loss less and lossy predictive coding, Transform coding, Image Compression standards- JPEG, JPEG 2000.

UNIT V

Video Processing: Definition of video signal, Analog and digital video, digital video applications, 3-D sampling and filtering, motion estimation and compensation signals, Transform coding, Predictive coding, Motion estimation algorithms, Search algorithms for Block Matching in motion estimation, video compression standards- MPEG-2/4, H.264, SVC.

Text Books:

1. R.C. Gonzalez & R.E. Woods, "Digital Image processing" Addison Wesley/ Pearson Ed., 2nd Edition, 2002.
2. S.Jayaraman, S.Esakkirajan, T.Veera Kumar, "Digital Image Processing"TMH, 2009.
3. J. W. Woods, "Multidimensional Signal, Image and Video Processing and Coding",2nd Edition, Academic Press, 2011.
4. Somka, Hlavac, Boyle , Digital Image Processing and Computer Vision –- Cengage Learning (Indian edition) 2008.

Reference Books:

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1. Ed. Al Bovik ,"Handbook of Image and Video Processing", 2nd Edition, Academic Press, 2000.
2. Rafael C. Gonzalez, Richard E Woods and Steven L., "Digital Image processing using MAT LAB", 2nd Edition, PEA, 2004.
3. Vipula Singh, "Digital Image Processing with MATLAB and LabView" , Elsevier.
4. M. Tekalp, "Digital Video Processing", Prentice Hall International

Course Title	Wireless and Mobile Communication				M.Tech. I Sem		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**	
1854107	**PE II**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exams**	**Total**
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					**End Exam Duration: 3Hrs**		

Course Objectives:

- To provide an introduction to the basic concepts and techniques used in digital image and video processing.
- To give an understanding of the two-dimensional sampling and quantization
- To study Edge detection and Image Enhancement Algorithms
- To Understand techniques for video sampling and motion estimation
- To Study techniques for image and video compression and object recognition

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

CO 1	Design appropriate mobile communication systems
CO 2	Distinguish various multiple-access techniques for mobile communications e.g. FDMA, TDMA, CDMA, and their advantages and disadvantages.
CO 3	Analyze path loss and interference for wireless telephony and their influences on a mobile communication system's performance
CO 4	Analyze and design CDMA system functioning with knowledge of forward and reverse channel details, advantages and disadvantages of using the technology

UNIT I

Introduction to Wireless Communications Systems: Evolution, Examples of Wireless Communication systems, Comparison, Second Generation Cellular Networks, WLL, Bluetooth and Personal Area Networks.

GSM Fundamentals: GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSM Logical Channels, Data Encryption in GSM, Mobility Management, Call Flows in GSM.2.5 G Standards: High speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS), 2.75 G Standards: EDGE

UNIT II

Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings. Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading.

UNIT III

Multiple access technologies: TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas.

Code Division Multiple Access: Introduction to CDMA technology, IS 95 system Architecture, Air Interface, Physical and logical channels of IS 95, Forward Link and Reverse link operation, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels.

UNIT IV

Equalization and Diversity: Equalizers in a communications receiver, Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving.

UNIT V

Higher Generation Cellular Standards: 3G Standards: evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, introduction to 5G.

Text Books

1. V.K.Garg, J.E.Wilkes, "Principle and Application of GSM", Pearson Education, 5th edition, 2008.
2. V.K.Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4th edition, 2009.
3. T.S.Rappaport, "Wireless Communications Principles and Practice", 2nd edition, PHI, 2002.
4. William C.Y.Lee, "Mobile Cellular Telecommunications", 2nd edition, TMH, 1995.

References:

1. Asha Mehrotra, "A GSM system Engineering" Artech House Publishers Bosten, London, 1997.
2. Aditya K. Jagannatham, "Principles of Modern Wireless Communication Systems", Publisher-McGraw Hill..
3. William C. Y. Lee, "Mobile Communications Engineering", Mc Graw Hill Publications
4. David Tse and Pramod Viswanath, " Fundamentals of Wireless Communications", Publisher - Cambridge University Press.

Course Title	Advanced Communication Network				M.Tech. I Sem			
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1854108	PE II	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs			

Course Objectives:

- To Understand advanced concepts in Communication Networking.
- To Design and develop protocols for Communication Networks.

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

CO 1	Understand advanced concepts in Communication Networking
CO 2	Design and develop protocols for Communication Networks
CO 3	Understand the mechanisms in Quality of Service in networking
CO 4	Optimize the Network Design.

UNIT I

Overview of Internet-Concepts, challenges and history: Overview of -ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.

UNIT II

Real Time Communications over Internet. Adaptive applications: Latency and throughput Issues, Integrated Services Model (intServ). Resource reservation in Internet. RSVP, Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP). Leaky bucket algorithm and its properties.

UNIT III

Packet Scheduling Algorithms-requirements and choices: Scheduling guaranteed service connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic, Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management.

UNIT IV

IP address lookup-challenges: Packet classification algorithms and Flow Identification-

Grid of Tries, Cross producting and controlled prefix expansion algorithms.

Admission control in Internet: Concept of Effective bandwidth, Measurement based admission control, Differentiated Services in Internet (DiffServ), DiffServ architecture and framework.

UNIT V

IPV4, IPV6, IP tunnelling, IPswitching and MPLS: Overview of IP over ATM and its evolution to IP switching, MPLS architecture and framework, MPLS Protocols, Traffic engineering issues in MPLS.

Text Books

1. Jean Wairand and Pravin Varaiya, "High Performance Communications Networks", 2 nd edition, 2000.
2. Jean Le Boudec and Patrick Thiran, "Network Calculus A Theory of Deterministic Queueing Systems for the Internet", Springer Veriag, 2001.
3. Zhang Wang, "Internet QoS", Morgan Kaufman, 2001.
4. Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical Approach" , Morgan Kaufman Publishers, 2004.

References:

1. George Kesidis, "ATM Network Performance", Kluwer Academic, Research Papers, 2005.
2. Principles of Wireless Networks – Kaveh Pah Laven and P. Krishna Murthy, 2002, PE
3. Wireless Digital Communications – Kamilo Feher, 1999, PHI.
4. Wireless Communication and Networking – William Stallings, 2003, PHI.

Course Title	Research Methodology and IPR				M.Tech. I Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1800109		L	T	P	C	Continuous Internal Assessment	End Exams	Total
		2	0	0	2	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs		

Course Objectives:

- To understand research problem formulation.
- To analyze research related information.

Course Outcomes: At the end of this course, students will be able to	
CO 1	Understand research problem formulation
CO 2	Analyze research related information
CO 3	Understand Intellectual Property rights and Patent rights

UNIT- I

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

UNIT-II

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

UNIT-III

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

UNIT- IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT-V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Text Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"

4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.

References:

1. Mayall , “Industrial Design”, McGraw Hill, 1992.
2. Niebel , “Product Design”, McGraw Hill, 1974.
3. Asimov , “Introduction to Design”, Prentice Hall, 1962.
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.

Course Title	DIGITAL SYSTEM DESIGN LAB					M.Tech. I Sem		
Course Code	Category	Hours/Week			Credits	Maximum marks		
1854110	Core	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		0	0	4	2	50	50	100
							End Exam Duration: 3Hrs	

Course Objectives:

- To Simulation and Verification of Logic circuits.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Identify, formulate, solve and implement problems in Adders, multipliers, Flip-Flops, Counters etc using RTL design tools.
CO 2	Use EDA tools like Mentor Graphics and Xilinx.

Experiments:

1. Simulation and Verification of Logic Gates.
2. Design and Simulation of Half adder, Serial Binary Adder, Multi Precession Adder, Carry Look Ahead Adder and Full Adder.
3. Simulation and Verification of Decoder, MUXs, Encoder using all Modeling Styles.
4. Modeling of Flip-Flops with Synchronous and Asynchronous reset.
5. Design and Simulation of Counters-Ring Counter, Johnson Counter, and Up-Down
6. Counter, Ripple Counter.
7. Design of a N-bit Register of Serial-in Serial-out, Serial in Parallel out, Parallel in serial
   out and Parallel in Parallel Out.
8. Design of Sequence Detector (Finite State Machine-Mealy and Moore Machines).
9. 4-Bit Multiplier, Divider. (for 4-Bit Operand)
10. Design ALU to Perform –ADD, SUB, AND-OR, 1‟s and 2‟s COMPLIMENT, Multiplication, Division.
11. Design of Shift register.

Course Title	Digital Communication Techniques Lab					M.Tech. I Sem		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum marks**		
1854111	**Core**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exams**	**Total**
		0	0	4	2	50	50	100
							End Exam Duration: 3Hrs	

Course Objectives:

- To Simulate and generate various modulated and demodulated signals.

Course Outcomes: On successful completion of this course, the students will be able to	
CO 1	Identify, formulate, solve and implement problems in communication systems
CO 2	Use simulation like Matlab / COM SIM

Experiments:

1. Simulate generation and detection of ASK Signal
2. Simulate generation and detection of FSK Signal
3. Simulate generation and demodulation of BPSK Signal
4. Simulate Rayleigh Fading Channel Using Either Clarke's Model or Jake's Model for different Doppler Spreads (Ex. 50 Hz and 100 Hz)
5. Generation of Maximal Sequences and Gold Sequences.
6. Performance Evaluation of QPSK System over Gaussian AWGN Channel.
7. Performance Evaluation of QPSK System over Rayleigh Fading Channel.
8. M-ary QAM with AWGN fading
9. Equalization of Multipath Channel using LMS or RLS Algorithms.
10. Performance Evaluation of RAKE Receiver over Slow Fading Channel.
11. Error detection and correction using CRC method.
12. Generation of Hamming code sequence.
13. Correlation: Auto And Cross.

Course Title	DISASTER MANAGEMENT				M.Tech. I Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1870A02	Audit Course	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		2	0	0	2	40	0	40
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs			

Course Objectives:

- To Understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

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

CO 1	Demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO 2	Evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO 3	Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
CO 4	Understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

UNIT-I

Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem.

UNIT-II

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT-III

Disaster Prone Areas In India: Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.

UNIT-IV

Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT-V

Risk Assessment: Disaster Risk**,** Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

Text Books:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Course Title	Microcontrollers and Programmable Digital Signal Processors				M.Tech II Sem.		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**	
1854201	**Core 3**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exams**	**Total**
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					**End Exam Duration: 3Hrs**			

Course Objectives:

- To understand Microcontrollers.
- To understand DSP Processors.

Course Outcomes: At the end of this course, students will be able to	
CO 1	Compare and select ARM processor core based SoC with several features/peripherals based on requirements of embedded applications
CO 2	Identify and characterize architecture of Programmable DSP Processors
CO 3	Develop small applications by utilizing the ARM processor core and DSP processor based platform

UNIT- I

ARM Cortex-M3 processor: Applications, Programming model – Registers, Operation modes, Exceptions and Interrupts, Reset Sequence Instruction Set, Unified Assembler Language, Memory Maps, Memory Access Attributes, Permissions, Bit-Band Operations, Unaligned and Exclusive Transfers, Pipeline, Bus Interfaces.

UNIT- II

Exceptions, Types, Priority, Vector Tables, Interrupt Inputs and Pending behaviour, Fault Exceptions, Supervisor and Pendable Service Call, Nested Vectored Interrupt Controller, Basic Configuration, SYSTICK Timer, Interrupt Sequences, Exits, Tail Chaining, Interrupt Latency.

UNIT- III

LPC 17xx microcontroller- Internal memory, GPIOs, Timers, ADC, UART and other serial interfaces, PWM, RTC, WDT

UNIT- IV

Programmable DSP (P-DSP) Processors: Harvard architecture, Multi port memory, architectural structure of P-DSP- MAC unit, Barrel shifters, VLIW architecture, Introduction to TI DSP rocessor family, TMS320C6000 series, architecture study, data paths, cross paths.

UNIT- V

Introduction to Instruction level architecture of C6000 family, Assembly Instructions memory addressing, for arithmetic, logical operations, Code Composer Studio for application development for digital signal processing, On chip peripherals , Processor benchmarking.

Text Books:

1. Joseph Yiu, “The definitive guide to ARM Cortex-M3”, Elsevier, 2nd Edition
2. Venkatramani B. and Bhaskar M. “Digital Signal Processors: Architecture, Programming and Applications” , TMH , 2nd Edition
3. Sloss Andrew N, Symes Dominic, Wright Chris, “ARM System Developer's Guide: Designing and Optimizing”, Morgan Kaufman Publication
4. Steve furber, “ARM System-on-Chip Architecture”, Pearson Education

References:

1. Frank Vahid and Tony Givargis, “Embedded System Design”, Wiley
2. Technical references and user manuals on www.arm.com, NXP Semiconductor
3. www.nxp.com and Texas Instruments www.ti.com.
4. Peter Pirsch, “Architectures For Digital Signal Processing”, Wiley Publications.

Course Title	Advanced DSP				M.Tech II Sem.		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1854202	Core 4	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs		

Course Objectives:

- To understand theory of different filters and algorithms\
- To understand theory of multirate DSP, solve numerical problems and write algorithms.
- To understand theory of prediction and solution of normal equations
- To know applications of DSP at block level

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

CO 1	Apply Multirate systems and DSP in signal processing.
CO 2	Realize linear prediction filters.
CO 3	Estimate Spectra from Finite-Duration Observations of Signals.

UNIT- I

Overview **:** Discrete-Time Signals, Sequences and sequence Representation, Discrete-Time Systems, Time-Domain Characterization and Classification of LTI Discrete-Time Systems. The Continuous-Time Fourier Transform, The discrete-Time Fourier Transform, energy Density Spectrum of a Discrete-Time Sequence, Band-Limited Discrete-Time signals, The Frequency Response of LTI Discrete-Time System.

UNIT-II

Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Applications in Multi rate systems.

UNIT- III

Linear prediction & optimum linear filters, stationary random process, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.

UNIT- IV

Estimation of Spectra from Finite-Duration Observations of Signals. Nonparametric Methods forPower Spectrum Estimation,Parametric Methods for Power Spectrum Estimation, Minimum-Variance Spectral Estimation, Eigenanalysis Algorithms for Spectrum Estimation.

UNIT-V

Application of DSP: Dual-Tone Multifrequency Signal Design, Spectral analysis of Sinusoidal Signals, Spectral analysis of nonstationary signals, Musical sound processing, Discrete-time analytic signal generation, Subband coding of speech and audio signals, transmultiplexers and Oversampling A/D and D/C converters.

TEXTBOOKS:

1. Digital Signal Processing by Sanjit K Mitra, Tata MCgraw Hill Publications.
2. Digital Signal Processing Principles, Algorithms, Applications by J G Proakis, D G anolokis, PHI.
3. Dr. Shaila D. Apte, "Advanced Digital Signal Processing", Wiley.
4. Jian Wang, Barmak Honarvar Shakibaei Asli, "Advanced Digital Signal Processing", Scitus Academics.

REFERENCES:

1. Discrete-Time Signal Processing by A V Oppenhiem, R W Schafer, Pearson Education.

2. DSP- A Practical Approach- Emmanuel C Ifeacher Barrie. W. Jervis, Pearson Education.

3. Modern spectral Estimation techniques by S. M .Kay, PHI, 1997.

4. Saeed V. Vaseghi, "Advanced Digital Signal Processing and Noise Reduction", Wiley; 4th edition.

Course Title	Advanced Computer Architecture				M.Tech II Sem.			
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1854203	PE III	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs			

Course Objectives:

- To learn about the evolution of computer architecture and its performance measuring parameters.
- To provide knowledge about instruction sets of different processors.
- To teach multiprocessors system interconnections.
- To know the instruction pipeline designs.

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

CO 1	To make student learn the advanced concepts related to computer architecture and storage systems
CO 2	Understand parallelism and pipelining concepts, the design aspects and challenges.
CO 3	Study and analyze the high performance scalable Multithreaded and multiprocessor systems

UNIT I

Fundamentals of Computer Design: Technology trends, cost- measuring and reporting performance quantitative principles of computer design.

Instruction Set Principles and Examples: classifying instruction set- memory addressing- type and size of operands- addressing modes for signal processing operations in the instruction set, instructions for control flow, encoding an instruction set, the role of compiler

UNIT II

Instruction Level Parallelism (ILP): overcoming data hazards reducing branch costs, high performance instruction delivery, hardware based speculation, limitation of ILP

ILP Software Approach: compiler techniques- static branch protection, VLIW approach, H.W support for more ILP at compile time- H.W verses S.W solutions

UNIT III

Memory Hierarchy Design: cache performance, reducing cache misses penalty and miss rate, virtual memory, protection and examples of VM.

UNIT IV

Multiprocessors and Thread Level Parallelism: Symmetric shared memory architectures, distributed shared memory, Synchronization, multi threading.

UNIT V

Storage Systems- Types, Buses, RAID, errors and failures, bench marking a storage device, designing a I/O system.

Interconnection Networks and Clusters: Interconnection network media, practical issues in interconnecting networks- examples, clusters, designing a Cluster

Text Books:

1. Computer Architecture A quantitative approach 3rd edition John L. Hennessy & David A. Patterson Morgan Kufmann (An Imprint of Elsevier).
2. Kai Hwang and A.Briggs "Computer Architecture and parallel processing", International Edition McGraw-Hill.
3. Kai Hwang, "Advanced Computer Architecture", McGraw Hill Education,1993.
4. Dezso Sima, Terence Fountain, Peter Kacsuk, "Advanced Computer Architectures", Pearson.

References:

1. H P Hayes, "Computer Architecture and Organization", McGraw Hill, 1978.
2. K. Hwang & Briggs , "Computer Architecture and Parallel Processing", McGraw Hill International, 1986
3. M J Flynn, "Computer Architecture: Pipelined and Parallel Processor Design", Narosa Publishing House, 2012.
4. M Sasikumar, D Shikkare and P Raviprakash, "Introduction to Parallel Processing", PHI, 2014.

Course Title	IOT and Applications				M.Tech II Sem.		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1854204	PE III	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs		

Course Objectives:

- To understand the basics of IOT.
- To study the Programming Using Arduino.
- To provide the knowledge about sensors and transducers.

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

CO 1	Understand the concept of IOT and M2M
CO 2	Study IOT architecture and applications in various fields.
CO 3	Study the security and privacy issues in IOT.

UNIT I

IoT& Web Technology The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

UNIT II

M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

UNIT III

IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

UNIT IV

IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, e-Health.

UNIT V

Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security.

Text Books:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st
2. Edition, VPT, 2014.
3. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting
4. Everything", 1stEdition, Apress Publications, 2013.

References:

1. CunoPfister, "Getting Started with the Internet of Things", OReilly Media, 2011.
2. Dr. Ovidiu Vermesan, Dr. Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013.
3. Catherine Mulligan, David Boyle, Jan Holler, Stamatis Karnouskos, and Vlasios Tsiatsis, "From Machine-to-Machine to the Internet of Things: Introduction to a Ne Age of Intelligence", Elsevier, 2014.
4. Boris Adryan, Dominik Obermaier, Paul Fremantle, "The Technical Foundations of IoT", Artech Houser Publishers, 2017.

Course Title	VLSI SIGNAL PROCESSING				M.Tech II Sem.		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1854205	PE III	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs		

Course Objectives:

- To understand DSP algorithms, its DFG representation.
- To understand algorithmic strength reduction in filters.

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

CO 1	Acquired knowledge about DSP algorithms, its DFG representation, pipelining and parallel processing approaches
CO 2	Ability to acquire knowledge about retiming techniques, folding and register minimization path problems
CO 3	Ability to have knowledge about algorithmic strength reduction techniques and parallel processing of FIR and IIR digital filters
CO 4	Acquired knowledge about finite word-length effects and round off noise computation in DSP systems

UNIT I

Introduction to DSP systems, Pipelined and parallel processing.

UNIT II

Iteration Bound, Retiming, unfolding, algorithmic strength reduction in filters and Transforms.

UNIT III

Systolic architecture design, fast convolution, pipelined and parallel recursive and adaptive filters, Scaling and round off noise.

UNIT IV

Digital lattice filter structures, bit level arithmetic, architecture, redundant arithmetic.

UNIT V

Numerical strength reduction, synchronous, wave and asynchronous pipe lines, low power design.

Text Books:

1. Keshab K. Parthi , VLSI Digital signal processing systems, design and implementation , Wiley, Inter Science, 1999.
2. Mohammad Isamail and Terri Fiez, Analog VLSI signal and information processing, McGraw Hill, 1994
3. S.Y. Kung, H.J. White House, T. Kailath, VLSI and Modern Signal Processing, Prentice Hall, 1985.
4. Hongjiang Song," VLSI Analog Signal Processing Circuits", Lulu.com

Reference Books:

1. Lulu.com," VLSI Digital Signal Processing Systems: Design and Implementation", Wiley.
2. M. Boyomi, "VLSI Signal Processing Technology", Springer.

Course Title	Detection and Estimation of Signals				M.Tech II Sem.			
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1854206	PE IV	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs			

Course Objectives:

- To provide knowledge about various estimation techniques like parametric and non parametric estimation techniques.
- To provide knowledge for finding good estimators.
- To provide enough knowledge for detection of signal in noise and estimate the signals in the presence of noise.

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

CO 1	Understand Interval Estimates.
CO 2	Analyze Detection of Signals in Noise.
CO 3	Apply Estimation of signals in Noise.

UNIT-I

Introduction to Discrete-Time Signals: Fourier Transform of a discrete time signal. Amplitude and phase spectrum. Frequency content and sampling rates. Transfer function. Frequency response.

Random – Discrete-time signals: Review of probability – Random data –Filtered signals – Autocorrelation and power spectral density.

UNIT-II

Statistics: Measurements, Nonparametric Estimators of Probability Distribution and Density Functions, Point Estimators of Parameters, Measures of the Quality of Estimators, Introduction to Interval Estimates, Distribution of Estimators, Tests of Hypotheses, Simple Linear Regression, Multiple Linear Regression.

UNIT-III

Detection of Signals in Noise: Minimum probability of Error criterion, Neyman-Pearson criterion for Radar detection of constant and variable, amplitude signals, Matched Filters, optimum formulation, detection of random signals, simple problems thereon with multisample cases.

UNIT-IV

Estimation of signals in Noise: Linear mean squared estimation, non-linear estimates, MAP and ML estimates, maximum likelihood estimate of parameters of linear system, simple problems theoreon.

UNIT- V

Recursive Linear Mean Squared Estimation: Estimation of a signal parameter. Estimation of time-varying signals, Kalman filtering, Filtering signals in noise, Treatment restricted to two variable case only, Simple problems.

Text Books:

1. Signal processing: Discrete Spectral analysis, Detection and Estimation, Mischa Schwartz and Leonard Shaw, Mc-Graw Hill Book Company, 1975.
2. Shanmugam and Breipohl, 'Detection of signals in noise and estimation', John Wiley & Sons, New York, 1985.
3. H. Vincent Poor, "An Introduction to Signal Detection and Estimation", Springer.
4. Bernard C. Levy, "Principles of Signal Detection and Parameter Estimation", Springer.

Reference Books:

1. E.L. Van Trees, Detection, Estimation and Modulation Theory, Wiley, New York, 1968.
2. Srinath, Rajasekaran & Viswanathan, Introduction to statistical Signal processing with Applications, Prentice Hall of India, New Delhi.

Course Title	OPTICAL NETWORKS				M.Tech II Sem.		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1854207	PE IV	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs			

Course Objectives:

- To understand further technology developments for future enhanced network.
- To understand network management functions.

Course Outcomes: At the end of this course, students will be able to	
CO 1	Understand Client Layers of the Optical Layer.
CO 2	Analyze network management functions and Photonic packet switching.
CO3	Apply statistical dimensioning models.

UNIT I

Client Layers of the Optical Layer: SONET/SDH, Multiplexing, SONET/SDH Layers, SONET Frame Structure, SONET/SDH Physical Layer, Elements of a SONET/SDH Infrastructure optical transport network, Frame Structure, Multiplexing, IP- routing and forwarding, multiprotocol label switching - Labels and Forwarding, Quality of Service, Signaling and Routing

UNIT II

WDM network elements: optical line terminals and amplifiers, optical add/drop multiplexers, OADM architectures, reconfigurable OADM, optical cross connects.

UNIT III

Control and management: network management functions, optical layer services and interfacing, performance and fault management, configuration management.

UNIT IV

Network Survivability: protection in SONET/SDH & client layer.

WDM network design: LTD and RWA problems, dimensioning wavelength routing

networks, statistical dimensioning models.

UNIT V

Photonic packet switching: Optical time division multiplexing, synchronization, header processing, buffering, burst switching, test beds.

Text Books:

1. Rajiv Ramaswami, Sivarajan, Sasaki, "Optical Networks: A Practical Perspective", MK, Elsevier, 3 rd edition, 2010.
2. C. Siva Ram Murthy and Mohan Gurusamy, "WDM Optical Networks: Concepts Design, and Algorithms", PHI, EEE, 2001.
3. Kumar N. Sivarajan, "Optical Networks: A Practical Perspective", Kindle.
4. Partha Pratim Sahu, "Fundamentals of Optical Networks and Components", CRC press.

References:

1. Debasish Datta, "Optical Networks", OUP Oxford; 1st edition.
2. Uyless Black, "Optical Networks", Pearson Education.
3. Debra Cameron," Optical Networking", John Wiley & Sons.
4. Schmutzer and Peter Tomsu," Next Generation Optical Networks", Prentice Hall; 1st edition.

Course Title	Biomedical Signal Processing	M.Tech II Sem.

Course Code	Category	Hours/Week			Credits	Maximum Marks		
1854208	PE IV	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs			

Course Objectives:

- To Understand different types of biomedical signal.
- To analyze different biomedical signals.

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

CO 1	Understand different types of biomedical signal.
CO 2	Identify and analyze different biomedical signals.
CO 3	Apply various biomedical signal processing methods.

UNIT I

Introduction: Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of bio-signals, Study of diagnostically significant bio-signal parameters

UNIT II

Data Compression Techniques: Lossy and Lossless data reduction Algorithms. ECG data compression using Turning point, AZTEC, CORTES, Huffman coding, vector quantization, DICOM Standards

UNIT III

Cardiological Signal Processing: Pre-processing, QRS Detection Methods, Rhythm analysis, Arrhythmia Detection Algorithms, Automated ECG Analysis, ECG Pattern Recognition. **Adaptive Noise Cancelling:** Principles of Adaptive Noise Cancelling, Adaptive Noise Cancelling with the LMS Adaptation Algorithm, Noise Cancelling Method to Enhance ECG Monitoring, Fetal ECG Monitoring.

UNIT IV

Signal Averaging, Polishing : Mean and trend removal, Prony's method, Prony's Method based on the Least Squares Estimate, Linear prediction, Yule – Walker (Y –W) equations, Analysis of Evoked Potentials.

UNIT V

Neurological Signal Processing: Modeling of EEG Signals, Detection of spikes and spindles Detection of Alpha, Beta and Gamma Waves. Auto Regressive (A.R.) modeling of seizure EEG. Sleep Stage analysis, Inverse Filtering, Least squares and polynomial modeling.

Text Books:

1. Rangaraj M. Rangayyan – Biomedical Signal Analysis. IEEE Press, 2001.
2. D. C. Reddy, Biomedical Signal Processing- principles, and techniques, Tata McGraw-Hill, 2005.
3. Willis J. Tompkins, Biomedical Digital Signal Processing, PHI.
4. Neeraj Vyas," Biomedical Signal Processing", Kindle.

Reference Books:

1. Ganesh Naik, “Biomedical Signal Processing: Advances in Theory, Algorithms and Applications”, Springer.
2. Walid A. Zgallai, “Biomedical Signal Processing and Artificial Intelligence in Healthcare”, Academic Press; 1st edition.
3. Amine Nait-Ali, “Advanced Biosignal Processing”,Springer; 2009th edition.
4. Joseph D. Bronzino, Hualou Liang, Donald R. Peterson, “Biosignal Processing: Principles and Practices”,CRC.

Course Title	Microcontrollers and Programmable Digital Signal Processors Lab				M.Tech. II Sem		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum marks**	
1854210	**Core**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exams**	**Total**
		0	0	4	2	50	50	100
							End Exam Duration: 3Hrs	

Course Objectives:

- To write the programming for DSP processors for various applications.

Course Outcomes: On successful completion of this course, the students will be able to	
CO 1	Install, configure and utilize tool sets for developing applications based on ARM processor core SoC and DSP processor.
CO 2	Develop prototype codes using commonly available on and off chip peripherals on the Cortex M3 and DSP development boards.

List of Assignments:

Part A) Experiments to be carried out on Cortex-M3 development boards and using GNU toolchain

1. Blink an LED with software delay, delay generated using the SysTick timer.
2. System clock real time alteration using the PLL modules.
3. Control intensity of an LED using PWM implemented in software and hardware.
4. Control an LED using switch by polling method, by interrupt method and flash the LED once every five switch presses.
5. UART Echo Test.
6. Take analog readings on rotation of rotary potentiometer connected to an ADC channel.
7. Temperature indication on an RGB LED.
8. Mimic light intensity sensed by the light sensor by varying the blinking rate of an LED.
9. Evaluate the various sleep modes by putting core in sleep and deep sleep modes.
10. System reset using watchdog timer in case something goes wrong.
11. Sample sound using a microphone and display sound levels on LEDs.

Part B) Experiments to be carried out on DSP C6713 evaluation kits and using Code Composer
Studio (CCS)

1. To develop an assembly code and C code to compute Euclidian distance between any two points
2. To develop assembly code and study the impact of parallel, serial and mixed execution
3. To develop assembly and C code for implementation of convolution operation
4. To design and implement filters in C to enhance the features of given input sequence/signal

Course Title	Advanced Digital Signal Processing lab					M.Tech. II Sem		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum marks**		
1854211	**Core**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exams**	**Total**
		0	0	4	2	50	50	100
							End Exam Duration: 3Hrs	

Course Objectives:

- To Design and verify various filters.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Design different digital filters in software.
CO 2	Apply various transforms in time and frequency.
CO 3	Perform decimation and interpolation.

List of Assignments:

1. Basic Signal Representation
2. Auto Correlation And Cross Correlation
3. Stability Using Hurwitz Routh Criteria
4. Sampling FFT Of Input Sequence
5. Butterworth Low pass And High pass Filter Design
6. Chebychev Type I,II Filter
7. Normal Equation Using Levinson Durbin
8. Decimation And Interpolation Using Rationale Factors
9. Maximally Decimated Analysis DFT Filter
10. Cascade Digital IIR Filter Realization
11. Convolution And M Fold Decimation &PSD Estimator
12. Estimation Of PSD
13. Separation Of T/F
14. Parallel Realization of IIR filter

Course Title	ENGLISH FOR RESEARCH PAPER WRITING				M.Tech II Sem.		
Course Code	**Category**	**Hours/Week**		**Credits**	**Maximum Marks**		
1870A01	**Audit Course**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exams**	**Total**
		2	0	0	0	40	0	40
Mid Exam Duration: 2Hrs					**End Exam Duration: 3Hrs**			

Course Objectives:

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

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

CO 1	Apply the writing skill while writing the results.
CO 2	Review the Literature, Methods, Results, Discussion, Conclusions.
CO 3	Understand Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences.

UNIT I

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT III

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

UNIT IV

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Suggested Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

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

Course Title	Microcomputer System Design				M.Tech III Sem.		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1854301	PE V	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs		

Course Objectives:

- To become familiar with 8086, 80X86, Pentium & Pentium IV Microprocessor Architecture, Instructions, Operating Modes, and Programming.
- To study I/O, Multi programming and Arithmetic Coprocessor

Course Outcomes: At the end of this course, students will be able to	
CO 1	Understand architectures of 80286, 80386, 80486 and Pentium Pro-processors.
CO 2	Analyze I/O Programming.
CO 3	Compare the various Microprocessors.

UNIT I

Review of 8086 Processor: Architecture, Register organization, Addressing Modes and Instruction Set (Brief treatment only), Difference between 8086 and 8088 with rest to pin structures.

The 80286 Microprocessors: Architecture, Register Organization, Addressing Modes and instruction sets of 80286 (brief treatment only)

UNIT II

The 80386, and 80486 Microprocessors: Architectural features, Register Organization, Memory management, Virtual 8086 mode, The Memory Paging Mechanism, Pin Definitions of 80386 and 80486 (brief treatment).

UNIT III

The Pentium and Pentium Pro-processors: The Memory System, Input/output system, Branch Prediction Logic, Cache Structure, Pentium Registers, Serial Pentium pro features.

The Pentium IV and Dual Core Microprocessors: Architecture, Special Registers and Pin Structures (brief treatment only)

UNIT IV

I/O Programming: Fundamentals of I/O Considerations Programmed I/O, Interrupt I/O, Block Transfers and DMA, I/O Design Example.

Introduction to Multiprogramming: Process Management, Semaphores Operations, Common Procedure Sharing, Memory Management, Virtual Memory Concept of 80286 and other advanced Processors.

UNIT V

Arithmetic Coprocessor, MMX and SIMD Technologies: Data formats for Arithmetic Coprocessor, Internal Structure of 8087 and Advanced Coprocessors. Instruction Set (brief treatment).

Text Books:

1. Barry, B. Brey, "The Intel Microprocessors,"8th Edition Pearson Education, 2009.
2. A.K. Ray and K.M. Bhurchandi,"Advanced Microprocessor and Peripherals," TMH.
3. YU-Chang, Glenn A. Gibson, "Micro Computer Systems: The 8086/8088 Family Architecture, Programming and Design" 2nd Edition, Pearson Education, 2007.
4. Mohamed Rafiquzzaman," Microprocessors and Microcomputer-Based System Design", CRC Press; 2nd edition.

Reference Books:

1. Walter A. Triebel, Avtar Singh, "The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications : Including the 80286, 80386, 80486, and Pentium Processors", Prentice Hall, 2000
2. Douglas V. Hall, "Microprocessors and Interfacing," Special Indian Edition, 2006.
3. Carol Anne Ogdin, "Microcomputer System Design and Techniques", IEEE Computer Society.
4. Dave Bursky, "Components for Microcomputer System Design: Selected from Electronic Design", Hayden Pub. Co.

Course Title	Joint Time Frequency Analysis & Multi Resolution Analysis				M.Tech III Sem.			
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
1854302	**PE V**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exams**	**Total**
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					**End Exam Duration: 3Hrs**			

Course Objectives:

- To introduction Transforms in signal processing.
- To understand Wavelets and its Applications.

Course Outcomes: At the end of this course, students will be able to	
CO 1	Introduction to Transforms in signal processing
CO 2	To understand Time -Frequency Analysis & Multiresolution Analysis
CO 3	Study of Wavelets and its Applications

UNIT I

Introduction: Review of Fourier Transform, Parseval Theorem and need for joint time-frequency Analysis. Concept of non-stationary signals, Short-time Fourier transforms (STFT), Uncertainty Principle, and Localization/Isolation in time and frequency, Hilbert Spaces, Banach Spaces, and Fundamentals of Hilbert Transform.

UNIT II

Bases for Time-Frequency Analysis: Wavelet Bases and filter Banks, Tiling's of Wavelet Packet and Local Cosine Bases, Wavelet Transform, Real Wavelets, Analytic Wavelets, Discrete Wavelets, Instantaneous Frequency, Quadratic time-frequency energy, Wavelet Frames, Dyadic wavelet Transform, Construction of Haar and Roof scaling function using dilation equation and graphical method.

UNIT III

Multiresolution Analysis: Haar Multiresolution Analysis, MRA Axioms, Spanning Linear Subspaces, nested subspaces, Orthogonal Wavelets Bases, Scaling Functions, Conjugate Mirror Filters, Haar 2-band filter Banks, Study of up samplers and down samplers, Conditions for alias cancellation and perfect reconstruction, Discrete wavelet transform and relationship with filter Banks, Frequency analysis of Haar 2-band filter banks, scaling and wavelet dilation equations in time and frequency domains, case study of decomposition and reconstruction of given signal using orthogonal framework of Haar 2band filter bank.

UNIT IV

Wavelets: Daubechies Wavelet Bases, Daubechies compactly supported family of wavelets; Daubechies filter coefficient calculations, Case study of Daub-4 filter design, Connection between Haar and Daub-4, Concept of Regularity, Vanishing moments. Other classes of wavelets like Shannon, Meyer, and Battle-Lamarie.

UNIT V

Bi-orthogonal wavelets and Applications: Construction and design. Case studies of biorthogonal 5/3 tap design and its use in JPEG 2000. Lifting schemes for generating orthogonalbases of second generation wavelets.

JTFA Applications: Speech, audio, image and video compression; signal denoising, feature extraction, inverse problem.

Text Books:

1. S. Mallat, "A Wavelet Tour of Signal Processing," 2nd Edition, Academic Press, 1999.
2. L. Cohen, “Time-frequency analysis”, 1st Edition, Prentice Hall, 1995.
3. G.Strang and T. Q. Nguyen, “Wavelets and Filter Banks",2nd Edition, Wellesley
4. Cambridge Press, 1998.

References:

1. I. Daubechies, "Ten Lectures on Wavelets", SIAM, 1992.
2. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1993.
3. M. Vetterli and J. Kovacevic, "Wavelets and Subband Coding", Prentice Hall, 1995.
4. Nandini Basumallick, S. V. Narasimhan, and S. Veena, “Introduction to Wavelet Transform: A Signal Processing Approach”, Alpha Science International Ltd.

Course Title	Pattern Recognition and Machine Learning				M.Tech III Sem.		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**	
1854303	**PE V**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exams**	**Total**
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					**End Exam Duration: 3Hrs**		

Course Objectives:

- To understand parametric and linear models for classification.
- To learn Linear models for classification, Linear discriminant functions and Neural Network.

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

CO 1	Study the parametric and linear models for classification.
CO 2	Design neural network and SVM for classification.
CO 3	Develop machine independent and unsupervised learning techniques.

UNIT I

Introduction to Pattern Recognition: Problems, applications, design cycle, learning and adaptation, examples, Probability Distributions, Parametric Learning - Maximum likelihood and Bayesian Decision Theory- Bayes rule, discriminant functions, loss functions and Bayesian error analysis

UNIT II

Linear models for classification: Discriminant functions, Two and multiple classes, Fisher's linear discriminant, Fisher's discriminant for multiple classes, The perceptron algorithm.

UNIT III

Neural Network: perceptron, multi-layer perceptron, backpropagation algorithm, error surfaces, practical techniques for improving backpropagation, additional networks and training methods.

UNIT IV

Linear discriminant functions - decision surfaces, two-category, multi-category, minimumsquared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine

UNIT V

Algorithm independent machine learning – lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design.

Unsupervised learning and clustering – k-means clustering, fuzzy k-means clustering, hierarchical clustering.

Text Books:

1. Richard O. Duda, Peter E. Hart, David G. Stork, “Pattern Classification”, 2nd Edition John Wiley & Sons, 2001.
2. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, “The Elements of Statistical Learning”, 2nd Edition, Springer, 2009.
3. C. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
4. Richard O. Duda, “Pattern Recognition”, Wiley India Pvt Ltd.

References:

1. Valliappa Lakshmanan, “Machine Learning Design Patterns”, Shroff/O'Reilly.
2. Manaranjan Pradhan, “Machine Learning using Python”, Wiley.

OPEN ELECTIVES

Course Title	Business Analytics					M.Tech III Sem.		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1871304	OE	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs			

Course Objectives:

- Understand the role of business analytics within an organization
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
- To become familiar with processes needed to develop, report, and analyze business data.Use decision-making tools/Operations research techniques
- Mange business process using analytical and management tools
- Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc

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

CO 1	Understand knowledge of data analytics
CO 2	Demonstrate the ability of think critically in making decisions based on data and deep analytics
CO 3	Demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making
CO 4	Demonstrate the ability to translate data into clear, actionable insights

UNIT I

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview.

UNIT II

Trendiness and Regression Analysis: Modeling Relationships and Trends in Data, simple Linear Regression.Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology

UNIT III

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization

UNIT IV

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.
Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Text Books:

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications", Pearson FT Press.
2. James Evans, "Business Analytics", persons Education.
3. Lynne Cooper, "Business NLP For Dummies".
4. Boris Schlossberg, "Technical Analysis of the Currency Market: Classic Techniques for Profiting from Market Swings and Trader Sentiment".

References:

1. Robert C. Hughes, "Human Capital Systems, Analytics, and Data Mining".
2. Junjiro Noguchi, "Analytic Function Theory of Several Variables".
3.I. Levin Richard, "Statistics for Management", Pearson, Eighth Edition
4. S. Christian Albright and Wayne L. Winston, "Business Analytics: Data Analysis and Decision Making".

Course Title	Industrial Safety				M.Tech III Sem.		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1871305	OE	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs		

Course Objectives:

- To know about Industrial safety programs and toxicology, Industrial laws , regulations and source models
- To understand about fire and explosion, preventive methods, relief and its sizing methods
- To analyze industrial hazards and its risk assessment.

Course Outcomes: At the end of this course, students will be able to	
CO 1	Analyze the effect of release of toxic substances
CO 2	Understand the industrial laws, regulations and source models
CO 3	Apply the methods of prevention of fire and explosions.
CO 4	Understand the relief and its sizing methods.
CO 5	Understand the methods of hazard identification and preventive measures.

UNIT I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods

UNIT IV

Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and

electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, Electrical motors, Types of faults in machine tools and their general causes

UNIT V

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Text Books:

1. Higgins & Morrow, "Maintenance Engineering Handbook", Da Information Services.
2. H. P. Garg, "Maintenance Engineering", S. Chand and Company.
3. Audels, "Pump-hydraulic Compressors", Mcgrew Hill Publication.Foundation Engineering Handbook.
4. J Maiti, Pradip Kumar Ray, "ndustrial Safety Management" Springer; 1st ed.

Reference Books:

1. L M Deshmukh, "Industrial Safety Management", .McGraw Hill Education
2. C. Asfahl and David Rieske, "Industrial Safety and Health Management", Pearson.
3. M. P. Poonia and S. C. Sharma, "Industrial Safety and Maintenance Management", Khanna Book Publishing.
4. Naseer Elahi, "Industrial Safety Management", Kalpaz Publications.

Course Title	Operation Research				M.Tech III Sem.		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**	
1871306	**OE**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exams**	**Total**
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					**End Exam Duration: 3Hrs**		

Course Objectives:

- To impart knowledge in concepts and tools of Operations Research.
- To understand mathematical models used in Operations Research.
- To apply these techniques constructively to make effective business decisions.

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

CO 1	Apply the dynamic programming to solve problems of discreet and continuous variables
CO 2	Apply the concept of non-linear programming
CO 3	Perform sensitivity analysis
CO 4	Model the real world problems and simulate it.

UNIT I

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

UNIT II

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

UNIT III

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

UNIT IV

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT V

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Text Books:

1. K.Rajagopal, “Operations Research”, PHI.
2. Hilier,Liebermann , “Operations Research” McGraw Hill Education.
3. Taha, “Introduction to Operations Research”, PHI.
4. Frederick S. Hillier, “Operations Research” McGraw Hill Higher Education.

References:

1. Maurice Saseini, ArhurYaspan& Lawrence Friedman, “Operations Research: Methods & Problems”.
2. Allen, David Edmund, “ Operations Research”.
3. J.K. Sharma, “Operations Research”.
4. Wayne L. Winston, Thomson Brooks, Cole, “Operations Research”.

Course Title	Cost Management of Engineering Projects				M.Tech III Sem.		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1871307	OE	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs		

Course Objectives:

- Establish systems to help streamline the transactions between corporate support departments and the operating units.
- Devise transfer pricing systems to coordinate the buyer-supplier interactions between decentralized organizational operating units.
- Use pseudo profit centers to create profit maximizing behavior in what were formerly cost centers

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

CO 1	Understand the concept of strategic cost management, strategic cost analysis – target costing, life cycle costing and Kaizen costing and the cost drive concept
CO 2	Describe the decision-making; relevant cost, differential cost, incremental cost and opportunity cost, objectives of a costing system
CO 3	Understand the meaning and different types of project management and project execution, detailed engineering activities.
CO 4	Understand the project contracts, cost behaviour and profit planning types and contents, Bar charts and Network diagram
CO 5	Analyse by using quantitative techniques for cost management like PERT/CPM.

UNIT I

Introduction and Overview of the Strategic Cost Management Process Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT II

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non- technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

UNIT III

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector.

UNIT IV

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Textbooks:

1. Project Management 2.0: Leveraging Tools, Distributed Collaboration, and Metrics for Project Success 1st Edition, Kindle Editionby Harold Kerzner
2. Cost Management Of Capital Projects by Kurt Heinze, Taylor & Francis Inc.
3. Cost Management of Construction Projects Donald Towey
4. The Engineer's Cost HandbookTools for Managing Project Costs*By Richard E. Westney*

References:

1. Architect's Essentials of Cost Management Michael D. Dell'Isola
2. Charles T. Horngren and George Foster, Advanced ManagementAccounting
3. Robert S Kaplan Anthony A. Alkinson, Management &CostAccounting
4. AshishK. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheelerpublisher

Course Title	Composite Materials				M.Tech III Sem.		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1871308	OE	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs		

Course Objectives:

- To Familiarize the basic expressions and methods used in the mechanics of composite structures. A complete theoretical and practical knowledge of composite materials.
- To understand the mechanical behaviour of anisotropic materials and how they differ from classical construction materials.

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

CO 1	Understand the specifics of mechanical behavior of layered composites compared to isotropic materials.
CO 2	Apply constitutive equations of composite materials and understand mechanical behavior at micro, macro and meso level.
CO 3	Determine stresses and strains in composites.
CO 4	Apply failure criteria and critically evaluate the results.
CO 5	Understand the mechanical behavior of composites due to variation in temperature and moisture.

UNIT I

INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II

REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT III

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT IV

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT V

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

References:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Course Title	Waste to energy				M.Tech III Sem.		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1871309	OE	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2Hrs					End Exam Duration: 3Hrs		

Course Objectives:

- To enable students to understand of the concept of Waste to Energy.
- To link legal, technical and management principles for production of energy form waste.
- To learn about the best available technologies for waste to energy.
- To analyze of case studies for understanding success and failures.
- To facilitate the students in developing skills in the decision making process.

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

CO 1	Apply the knowledge about the operations of Waste to Energy Plants.
CO 2	Analyze the various aspects of Waste to Energy Management Systems.
CO 3	Carry out Techno-economic feasibility for Waste to Energy Plants.
CO 4	Apply the knowledge in planning and operations of Waste to Energy plants.

UNIT I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion -

anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India

Text Books:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
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