University Institute of Technology (UIT)

Silver Wood Estate, H. P. University, Shimla-171005 (NAAC accredited "A-Grade" University)

Department

of

ELECTRONICS & COMMUNICATION ENGINEERING

Course Structure & Syllabus

for

Master of Technology

in

ELECTRONICS & COMMUNICATION ENGINEERING

Semester I-IV

Course Structure & Scheme

COURSE SCHEME
M.Tech. (Electronics & Communication Engineering)

First Semester

S. No.	Course No.	Course Name	L	T	P	C	Semester End Marks	
							External	Internal
1.	MEC-1001	Advanced Communication Systems and Networks	4	0	0	4	100	50
2.	MEC-1002	Embedded Systems and IoT	4	0	0	4	100	50
3.	MEC-1003	Advanced Digital Signal Processing	4	0	0	4	100	50
4.	MEC-1004	Solid State Devices	4	0	0	4	100	50
5.	MEC-1005	Electronics Simulation Lab-I	0	0	6	3	100	50
6.	RM-1001	Research Methodology	2	0	0	2	100	50
7.	MAC-1001	Audit Course - I						
Total			**18**	**0**	**6**	**21**	**600**	**300**
							Total: 900	

Second Semester

S. No.	Course No.	Course Name	L	T	P	C	Semester End Marks	
							External	Internal
1.	MEC-2001	Advanced Antenna	4	0	0	4	100	50
2.	MEC-2002	Machine Intelligence and Learning	4	0	0	4	100	50
3.	MEC-2003	VLSI Circuit Design	4	0	0	4	100	50
4.	MEC-XXXX	Elective-I	3	0	0	3	100	50
5.	MEC-XXXX	Elective-II	3	0	0	3	100	50
6.	MEC-2004	Electronics Simulation Lab -II	0	0	6	3	100	50
7.	MAC-2001	Audit Course - II	0	0	0	4		
Total			**18**	**0**	**6**	**21**	**600**	**300**
							Total: 900	

Third Semester

S. No.	Course No.	Course Name	L	T	P	C	Semester End Marks	
							External	Internal
1.	MEC-3001	Dissertation -I	-	-	-	13	250	100
Total			-	-	-	**13**	**Total: 350**	

Forth Semester

S. No.	Course No.	Course Name	L	T	P	C	Semester End Marks	
							External	Internal
1.	MEC-4001	Dissertation -II	-	-	-	15	250	100
Total			-	-	-	**15**	**Total: 350**	

Total Credits: 70

List of Electives

S. No.	Course No.	Course Name	L	T	P	C
1.	MEC-2005	Compound Semiconductors and RF Devices	3	0	0	3
2.	MEC-2006	Flexible and Printed Electronics	3	0	0	3
3.	MEC-2007	Reliabilty of Electronic Devices	3	0	0	3
4.	MEC-2008	Microstrip Antenna	3	0	0	3
5.	MEC-2009	Low Power CMOS VLSI Design	3	0	0	3
6.	MEC-2010	Advanced Computer Networks and Protocols	3	0	0	3
7.	MEC-2011	Sensor Technology and MEMS	3	0	0	3
8.	MEC-2012	Design for IoT	3	0	0	3
9.	MEC-2013	Computational Electromagnetics	3	0	0	3
10.	MEC-2014	Deep Learning for Computer Vision	3	0	0	3
11.	MEC-2015	Analog and Mixed Signal Circuit Design	3	0	0	3
12.	MEC-2016	VLSI Interconnects	3	0	0	3
13.	MEC-2017	Nanoscale Devices	3	0	0	3
14.	MEC-2018	Biomedical Electronics	3	0	0	3

Legend:

L - Number of lecture hours per week

T - Number of tutorial hours per week

P - Number of practical hours per week

C- Total no. of credits

Detailed Syllabus

SEMESTER-I

Name of the Course	**Advanced Communication Systems and Networks**		
Course Code	**MEC-1001**	**Credits-4**	**L-4, T-0, P-0**
Total Lectures	**52 (1 Hr Each) (L=39, T=13 for each semester)**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

Course Objectives: To understand the fundamentals of wireless communication, wireless channel modeling (large scale and small scale). Calculate the capacity of wireless channels along with performance of digital modulation techniques over wireless fading channels.

Section	Course Content
Section A	Large scale fading model: Radio Wave Propagation, Free-Space Path Loss, Ray Tracing, Two-Ray Model, Ten-Ray Model (Dielectric Canyon), General Ray Tracing, Empirical Path Loss Models, Okumura Model, Hata Model, Small scale fading model: Time-Varying Channel Impulse Response, Autocorrelation, Cross Correlation, and Power Spectral Density Level Crossing Rate and Average Fade Duration, Finite State Markov Channels, Wide band Fading Models, Power Delay Profile, Coherence Bandwidth,
Section B	Diversity: Diversity techniques for binary signals, multiphase signals, M-ary orthogonal signals on multipath channel ,Receiver Diversity, System Model, Combining techniques, Moment Generating Functions in Diversity Analysis for MRC, EGC, SC of Non-coherent and Differentially Coherent Modulation.
Section C	Capacity of Wireless Channels: Capacity in AWGN, Capacity of Flat-Fading Channels, Channel and System Model, Capacity with Receiver Diversity, Capacity Comparisons, Capacity of Frequency- Selective Fading Channels. Equalization: Equalizer Types, Folded Spectrum and ISI-Free Transmission, Linear Equalizers, Zero Forcing (ZF) Equalizers, MMSE Equalizer.
Section D	Multicarrier Modulation: Data Transmission using Multiple Carriers, Overlapping Sub-channels, Mitigation of Sub carrier Fading, Discrete Implementation of Multi-carrier, Cyclic Prefix, OFDM, PAPR, Frequency and Timing Offset, Multi-user Channels, Multiple Access, Downlink Channel Capacity, Uplink Channel Capacity, Capacity in

	AWGN, Fading, and with Multiple Antennas.

Course Outcomes (COs):

At the end of the course students will able to:

CO1: . Understand the fundamentals and advancement in wireless communication systems.
CO2: Analyze the modeling (large scale and small scale) of wireless Channel.
CO3: Evaluate the performance of digital modulation techniques in wireless environment.

Text Book

1. Goldsmith Andrea, Wireless Communications, Cambridge University Press (2005).
2. Rappaport, T.S., Wireless Communications, Pearson Education 2nded (2007).
3. Paulraj, Arogyaswami, Gore, Dhananjay and Nabar, Rohit, Introduction to Space- Time Wireless Communications, Cambridge University Press(2008).

Reference Book

1. Tse, David and Viswanath, Pramod, Fundamentals of Wireless Communication, Cambridge University Press (2006).

<table>
<tr><td>Name of the Course</td><td colspan="3">Embedded Systems and IoT</td></tr>
<tr><td>Course Code</td><td>MEC-1002</td><td>Credits-4</td><td>L-4, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">52 (1 Hr Each) (L=39, T=13 for each semester)</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials/ Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.</td></tr>
<tr><td colspan="4">Course Objectives: The course aims to understand the basic concepts of embedded system, understanding of different types of programming languages used for embedded systems. It also aims to understand the fundamentals of RTOS and application development techniques and also provide students with good depth of knowledge of Designing Embedded and IOT Systems for various applications.</td></tr>
</table>

Section	Course Content
Section A	Components of embedded Systems, Classification of an Embedded system. Architecture of Embedded system. General purpose computers vs embedded system, Embedded System Design Process, Various Embedded cores controller. Communication Interface: Onboard and External Communication Interfaces.Embedded system with IOT connectivity.
Section B	Processor and memory organization, Instruction level parallelism, Performance metrics of a Processor. Devices and communication interfaces: Timer and counting devices, Watchdog timer, Real time clock, Serial communication protocols: UART, SPI, I2C. Bluetooth, Zigbee, USB.
Section C	RTOS Fundamentals: Interrupts: Basics, Interrupt request, Role of Interrupt handler, Interrupt vector table, Context switching during Interrupts, Nesting of Interrupts, Shared-Data problem, Solving shared-data problem with and without disabling Interrupts, Atomic and Critical Section of the code, Interrupt latency, Software Architectures: Round-robin architecture without and with Interrupts, Function-Queue-Scheduling architecture.

Section D	Physical design of IoT, Logical design of IoT, IoT enabling technologies: Wireless Sensor Networks, Cloud Computing, Big data analytics. Introduction to IOT based Embedded Systems: Basic architecture of an IoT based Embedded Systems., Embedded Hardware for IoT applications, like Raspberry Pi, Arduino, and ARM development board.

Course Outcomes (COs):

Upon successful completion of the course, the students will be able to:

CO1: Recognize the Embedded system and its programming, Embedded Systems on a Chip (SoC) and the use of VLSI designed circuits.

CO2: Recognize the Real time Operating system with Task scheduling and Kernel Objectives types optical amplifier.

CO3: The students would be able to understand the various communication and networking protocols used for developing IoT enabled devices.

Text Books:

1. Raj Kamal, Embedded System Architecture, Programming and Design, Tata McGraw Hill, (2004).
2. Heath, S., Embedded Systems Design, Elsevier Science (2003).

Reference Books:

1. Simon, D.E., An Embedded Software Primer, Dorling Kindersley (2005).
2. Andrew N. Sloss, ARM System Developer's Guide Designing and Optimizing System Software, Morgan Kaufman Publication (2010).

<table>
<tr><td>Name of the Course</td><td colspan="3">Advanced Digital Signal Processing</td></tr>
<tr><td>Course Code</td><td>MEC-1003</td><td>Credits-4</td><td>L-4, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">52 (1 Hr Each) (L=39, T=13 for each semester)</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials/ Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.</td></tr>
<tr><td colspan="4">Course Objectives:This course aims to introduce fundamentals of discrete-time linear systems and digital signal processing. This course emphasizes theory but also includes design and applications.</td></tr>
</table>

Section	Course Content
Section A	Review of Discrete Time Signals: Signals and systems, Sampling and Reconstruction of signals, Z-transform, discrete-time Fourier transform (DTFT) and discrete Fourier transform (DFT), The fast Fourier transform (FFT) algorithms: Decimation-in- Time and Decimation-in-Frequency FFT Algorithms, Design of Digital filters: Linear time-invariant(LTI) systems, convolution, ideal and realizable filter, liner phase filters, Design of FIR Filters, Symmetrical, Asymmetrical FIR Filters.
Section B	Implementation of Discrete-Time Systems: Block diagram representation, Structures for digital filtering, FIR digital filter structures: Direct form, Cascade form, Frequency sampling and lattice structures, IIR digital filter structures: Direct form, Cascade form, Parallel form, Lattice and Ladder-Lattice structures, Representation of numbers, Quantization of filter coefficients, Round-off effects. Spectrum Estimation, Parametric and non-Parametric methods
Section C	Multi-Rate Signal Processing: Decimation and Interpolation by integer and rational factor, Aliasing error, Sample rate conversion, Poly-phase structures,

	Multi-stage implementation of Sampling rate converters, Multi- rate filter banks, Quadrature mirror filters, Applications.
Section D	Adaptive Filters: Concept of Adaptive filters, LMS algorithm, Recursive Least Square algorithm, Adaptive Ladder-Lattice filters, Applications of Adaptive filters. Time-Frequency Analysis: Concept of time-frequency analysis, Forward and Inverse Wavelet transform, Wavelet families, Multi-resolution analysis.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: The students will be able to. Recognize the concept of discrete time signal processing and filter design techniques. Interpret multi-rate signal processing and its application.

CO2: Analyze the theory of adaptive filter design and its applications. Evaluate the spectra of random signals and variety of modern and classical spectrum estimation techniques.

Text Books:

1. Proakis, J. G. Digital Filters: Analysis, Design and Applications, McGraw Hill (1981) 2nd Ed.
2. Proakis, J.G., Manolakis, D.G., Digital Signal Processing, Prentice Hall of India (2001) 3rd Ed.

Reference Books:

1. Antoniou, A., Digital Filters: Analysis, Design and Applications, McGraw Hill (2000) 2nd Ed.
2. Oppenheim, A. V., Schafer, R. W., Discrete-Time Signal Processing, Pearson (2002) 2nd Ed.

Name of the Course	**Solid State Devices**		
Course Code	**MEC-1004**	**Credits-4**	**L-4, T-0, P-0**
Total Lectures	**52 (1 Hr Each) (L=39, T=13 for each semester)**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

Course Objectives: The course aims to introduce the basics of semiconductor materials and devices. To understand the Basic devices such as pn junction diode, metal-semiconductor contacts and metal oxide semiconductor structures and I-V and C-V characteristics of these devices will also be discussed.

Section	**Course Content**
Section A	Carrier statistics, Carrier transport, Carrier mobility, Scattering mechanisms, Hall effect measurements, High field property, Non-equilibrium conditions, Quasi Fermi levels, Recombination processes, Current density and continuity equations, Surface recombination, Surface states, Excitons in semiconductors. Basic structure of pn junction, Zero applied bias: Electric field, built-in potential, junction capacitance.
Section B	Current transport in pn junction diode, Small signal model of pn diode, Diffusion capacitance, Generation-recombination currents, Junction breakdown mechanisms. Hetero junctions: Band alignments, energy band diagrams of hetero junctions, formation of two dimensional electron gas. Metal-semiconductor contacts: Schottky barrier diode, Energy band diagrams, Fermi level pinning, C-V characteristics of a Schottky diode, Current transport processes and I-V characteristics, Ohmic contacts.
Section C	Ideal MOS structure, energy band diagrams under accumulation, depletion and inversion conditions, surface potential, flat band voltage and threshold voltage, variation of electric field and potential across a MOS structure, various types of charges in a MOS structure, some properties of silicon based MOS structures.
Section D	MOSFET: Output and transfer characteristics, I-V relationships, non ideal effects in a MOSFET, CMOS technology. Optical devices: Optical absorption, Solar cells, conversion efficiency, Photoconductors and photodiodes.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Apply the knowledge of basic semiconductor material physics and understand fabrication processes.

CO2: Analyse the characteristics of various electronic devices like diode transistor etc.

CO3: Classify and analyze the various circuit configurations of Transistor and MOSFETs.

CO4: Illustrate the qualitative knowledge of Electronic Devices.

Text Books:

1. D. A. Neamen, Semiconductor Physics and Devices, Tata Mcgraw Hill.
2. S. M. Sze, Physics of Semiconductor Devices, John Wiley.

Reference Books:

1. Streetman, B. and Banerjee, S., Solid State Electronics, Prentice Hall India, (2006).
2. Sze, S.M., Physics of Semiconductor Devices, John Wiley, (1981). 91st Senate approved Courses Scheme & Syllabus for M.Sc. (Physics) 2017 Page 37
3. Mishra, Umesh K. and Singh, Jaspreet, Semiconductor Device Physics and Design, Springer, (2008).
4. Pierret, R.F., Semiconductor Device Fundamentals, Pearson Education Inc., (2006).

<table>
<tr><td>Name of the Course</td><td colspan="3">Electronics Simulation Lab-I</td></tr>
<tr><td>Course Code</td><td>MEC-1005</td><td>Credits-3</td><td>L-0,T-0,P-6</td></tr>
<tr><td>Lectures to be delivered</td><td colspan="3">6 Hrs. per week</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min Pass Marks: 40</td><td>Max. Time: 3Hrs</td></tr>
<tr><td colspan="3">Internal Assessment: (based on Continuous Lab Work Assessment: 20%, Experiment Performance: 30%, Attendance 10%, Viva: 40%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Course Objective: To Analyse the characteristics of various electronic devices and provide hands-on experience on the behavioural and structural modelling in the Finite Element Method based software tools.</td></tr>
<tr><td>Sr. No.</td><td colspan="3">Contents</td></tr>
<tr><td>1.</td><td colspan="3">Semiconductor Lab:
1. Design and analysis of NMOS and PMOS
2. Determination of NMOS and PMOS device parameter (VT0,k',λ,γ,SS)
3. Design and analysis of pn junction diode
4. Design and analysis of Schottky diode</td></tr>
<tr><td>2.</td><td colspan="3">Advanced Digital Signal Processing Lab:
1. Design of Chebychev Type I,II Filters.
2. Cascade Digital IIR Filter Realization.
3. Parallel Realization of IIR filter.
4. Estimation of power spectrum using parametric methods (yule-walker & burg).
5. Design of LPC filter using Levinson-Durbin algorithm.
6. Time-Frequency Analysis with the Continuous Wavelet Transform.
7. Signal Reconstruction from Continuous Wavelet Transform Coefficients.</td></tr>
<tr><td colspan="4">Course Outcomes (COs):
After successful completion of the course, students will be able to:
CO1: Determine the characteristics of electronics devices for modelling and analysis.
CO2: Study and analysis of various propagation losses in optical wave guide</td></tr>
<tr><td colspan="4">Text Books:
1. Design of Analog CMOS Integrated Circuits, by BehzadRazavi, McGraw-Hill
2. Textbook of Finite Element Analysis P. Seshu © 2003 by PHI Learning Private Limited, New Delhi
3. Sung-Mo Kang, Yusuf Liblebici, “CMOS Digital Integrated Circuits,” Tata McGraw Hill 2003.</td></tr>
</table>

<table>
<tr><td>Name of the Course</td><td colspan="3">Research Methodology</td></tr>
<tr><td>Course Code</td><td>RM-1001</td><td>Credits-2</td><td>L-2, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">52 (1 Hr Each) (L=39, T=13 for each semester)</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.</td></tr>
<tr><td colspan="4">Course Objectives: To understand the formulation of a viable research question and to distinguish probabilistic from deterministic explanations.</td></tr>
<tr><td>Section</td><td colspan="3">Course Content</td></tr>
<tr><td>Section A</td><td colspan="3">Research Aptitude: Meaning of Research, Objectives of Research, and Motivation in Research, Types of Research, Research Approaches, and Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is done. Research Process: Reviewing the literature, Formulation of research problem, Nature and type of variables, Hypothesis - meaning, types, development of hypothesis and its testing, Meaning & Functions of Research Design.</td></tr>
<tr><td>Section B</td><td colspan="3">Data Analysis: Sources, acquisition and interpretation of data, Quantitative and qualitative data, Graphical representation and mapping of data, Sensitivity Analysis with Data Tables, Optimization with EXCEL Solver, Summarizing Data with Histograms and Descriptive Statistics, Pivot Tables, Summarizing Data with database statistical functions, using correlation, Multiple Regression, Using Sampling to Analyse Data.</td></tr>
<tr><td>Section C</td><td colspan="3">Significance of Report Writing : Different Steps in writing Report, Layout of the Research Report, Types of Reports, Mechanics of Writing a Research Report, Art of scientific</td></tr>
</table>

	writing- Steps to better writing, flow method, organization of material and style, Drawing figures, graphs, tables, footnotes, references etc. in a research paper
Section D	Use of Internet in Research Work : Use of internet networks in research activities in searching material, paper downloading, submission of papers, relevant websites for journals and related research work. Introduction to Patent laws etc., process of patenting a research finding, Copy right, Cyber laws.

Course Outcomes (COs):

At the end of the course students will able to:

CO1: Explain key research concepts and issues.

CO2: Read, comprehend, and explain research articles in their academic discipline.

Text Book:

1. Kothari, C. R., "Research Methodology Methods and Techniques", Wiley Eastern Ltd.

References Book:

1. WayneL.Winston,"MicrosoftExcelDataAnalysisandBusinessModelling",Microsoft Press.
2. Kumar, "Research Methodology: A Step-by-Step Guide for Beginners", Pearson Education.

SEMESTER-II

<table>
<tr><td>Name of the Course</td><td colspan="3">Advanced Antenna</td></tr>
<tr><td>Course Code</td><td>MEC-2001</td><td>Credits-4</td><td>L-4, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">52 (1 Hr Each) (L=39, T=13 for each semester)</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials/ Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.</td></tr>
<tr><td colspan="4">Course Objectives: The objective of this course is to provide an in-depth understanding of modern antenna concepts, and practical antenna design for various applications.</td></tr>
</table>

Section	Course Content
Section A	Fundamental Concepts: Radiation pattern, near- and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.
Section B	Radiation from Wires and Loops: Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.

Section C	Aperture, Horn and Reflector Antennas: Huygens' principle, radiation from rectangular and circular apertures, Radiation from sectoral and pyramidal horns, prime-focus parabolic reflector and cassegrain antennas.
Section D	Microstrip Antennas: Basic characteristics, feeding methods, methods of analysis, design of rectangular and circular patch antennas. Smart Antennas: Introduction to Smart Antennas, Architecture of a Smart Antenna System: Transmitter and Receiver, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Applications of Smart Antennas.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Acquire a basic knowledge of basic antenna concepts.

CO 2: Have ability to understand radiation from wire and loops.

CO 3: Acquire brief knowledge about aperture, horn and reflector antennas.

CO 4 : To Familiarize with smart and microstrip antennas.

Text Books:

1. Balanis, C.A., "Antenna Theory and Design", 3rd Ed., John Wiley &Sons (2005).
2. GJordan, E.C. and Balmain, K.G., "Electromagnetic Waves and RadiatingSystems", 2nd Ed., Prentice-Hall of India.
3. Garg, R., Bhartia, P., Bahl, I. and Ittipiboon, A., "Microstrip AntennaDesign Handbook", Artech House (2001).
4. Elliot, R.S., "Antenna Theory and Design", Revised edition, Wiley IEEE Press (2003)

Reference Books:

1. Stutzman, W.L. and Thiele, H.A., "Antenna Theory and Design", 2nd Ed., John Wiley & Sons (1998).
2. Introduction to Smart Antennas, Constantine A. Balanis, Panayiotis I.Ioannides, Morgan & Claypool Publishers, 2007.

<table>
<tr><td>Name of the Course</td><td colspan="3">Machine Intelligence and Learning</td></tr>
<tr><td>Course Code</td><td>MEC-2002</td><td>Credits-4</td><td>L-4, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">52 (1 Hr Each) (L=39, T=13 for each semester)</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.</td></tr>
<tr><td colspan="4">Course Objectives: The course aims to make students understand and implement classical machine learning models and algorithms. It also aims to develop skills for recent machine learning problems corresponding to different applications.</td></tr>
</table>

Section	Course Content
Section A	Introduction to machine learning: Introduction and History of Machine Learning. Basic Concepts of Machine Learning, Examples of Machine learning application, how artificial Intelligence relates to Machine Learning, Machine Learning Concepts, Different phases of prediction modeling.
Section B	Supervised Learning: Learning class from examples, learning multiple classes Non-parametric Methods: k-Nearest Neighbours (KNN), Introduction and building a Decision Tree. Representing disjunctive concepts as trees and rules, Random Forest Discriminative Learning models: Support Vector Machine (SVM) and its Kernels.
Section C	Unsupervised Learning: Introduction to clustering, Unsupervised Learning: Introduction to clustering, k-Means clustering algorithm and Hierarchical Clustering, Supervised

	learning after clustering, Introduction to regression:Linear Regression and locally weighted or logistic.
Section D	Regression Reinforcement Learning: Introduction to Reinforcement Learning, Learning Task, Non-deterministic Rewards and actions with examples. Evaluation Metrics: Introduction, Binary Classification, performance, Score based models and Point matrices.

Course Outcomes (COs):

At the end of the course students will able to:

CO1: Have comprehensive knowledge of machine learning and its applications.

CO2: Choose the relevant models and algorithms to turn available data into valuable and useful information.

Text Books:

1. Alpaydin, Ethem., "Introduction to machine learning", second edition.
2. Tom M. Mitchell., "Machine Learning", McGraw-Hill Science/Engineering/Math; ISBN: 0070428077.

Reference Books:

1. Peter Flach, Machine Learning: The Art and Science of Algorithms that make sense of Data, Cambridge University Press.

<table>
<tr><td>Name of the Course</td><td colspan="4">VLSI Circuit Design</td></tr>
<tr><td>Course Code</td><td>MEC-2003</td><td>Credits-4</td><td colspan="2">L-4,T-0,P-0</td></tr>
<tr><td>Lectures to be delivered</td><td colspan="4">52 (1 Hr Each) (L=39, T=13 for each semester)</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min Pass Marks: 40</td><td colspan="2">Max. Time: 3Hrs</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials /Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td colspan="2">Max Marks: 50</td></tr>
<tr><td colspan="5">Instructions</td></tr>
<tr><td colspan="5">For Paper Setters: The question paper will consist of five sections A, B, C, D and E. Section E will be Compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C and D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.</td></tr>
<tr><td colspan="5">For Candidates: Candidates are required to attempt five questions in all selecting one question from each of the section A, B, C and D of the question paper and all the subparts of the questions in section E. Use of non-programmable calculators is allowed.</td></tr>
<tr><td colspan="5">Course objective: To acquaint the students with the fundamental concepts of digital and analog VLSI circuit design.</td></tr>
<tr><td>Sections</td><td colspan="4">Course Content</td></tr>
<tr><td>Section A</td><td colspan="4">Review of MOSFET operation CMOS inverter – static and dynamic characteristics, Power-Speed Trade-off, power dissipation.
Combinational logic: Transistor sizing in static CMOS logic gates, static CMOS logic gate sizing considering method of logical effort, dynamic logic, common mode and other cross-coupled logic.</td></tr>
<tr><td>Section B</td><td colspan="4">Combinational & Sequential logic: MOS logic circuits with depletion NMOS loads, CMOS logic circuits, complex logic circuits, CMOS transmission gates. Behaviour of bistable elements, SR latch circuit, Clocked latch and flip-flop circuits, CMOS D latch and edge triggered flip-flop.</td></tr>
<tr><td>Section C</td><td colspan="4">Analog MOS Process. Passive & Active Current Mirrors: Basic current mirrors, Cascode current mirror, Active loads, and voltage and current references.</td></tr>
</table>

Section D	Frequency response of integrated circuits: Single Stage (CS,CG,CD) amplifiers, Cascade Stage; frequency response (miller effect) of CG, CS, CD, Operation of Basic Differential Pair, differential pair with MOS loads, Frequency response of Cascade & Differential Pair. MOS operational amplifiers

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Study and analyze the performance of CMOS inverter circuits on the basis of their operation and working.

CO2: Design of CMOS combinational and sequential logic circuits.

CO3: Acquire a basic knowledge of analog IC design including small signal models, analog MOS processes.

CO4: Design of single stage and differential stage amplifiers with and without current mirror circuits, respectively.

Text Books:

1. Jan M. Rabaey, Anantha Chandra kasan, Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective," Prentics Hall 2003.
2. Sung-Mo Kang, Yusuf Liblebici, "CMOS Digital Integrated Circuits," Tata McGraw Hill 2003.
3. Razavi, B., Design of Analog CMOS Integrated Circuits, Tata McGraw Hill (2008).
4. Gray, P.R., Hurst, P.J., Lewis, S.H., and Meyer, R.G., Analysis and Design of Analog Integrated Circuits, John Wiley (2001) 5th ed.

Reference Books:

1. R. Jacob Baker, "CMOS Mixed-Signal Circuit Design," Wiley India Pvt. Ltd. 2009.
2. Ivan Sutherland, R. Sproull and D. Harris, "Logical Effort: Designing Fast CMOS Circuits", Morgan Kaufmann 1999.
3. Allen, P.E. and Holberg, D.R., CMOS Analog Circuit Design, Oxford University Press (2002) 2nd ed.

<table>
<tr><td colspan="2">Name of the Course</td><td colspan="3">Electronics Simulation Lab-II</td></tr>
<tr><td colspan="2">Course Code</td><td>MEC-2004</td><td>Credits-3</td><td>L-0,T-0,P-6</td></tr>
<tr><td colspan="2">Lectures to be delivered</td><td colspan="3">6 Hrs. per week</td></tr>
<tr><td colspan="2">Semester End Examination</td><td>Max Marks: 100</td><td>Min Pass Marks: 40</td><td>Max. Time: 3Hrs</td></tr>
<tr><td colspan="4">Internal Assessment: (based on Continuous Lab Work Assessment: 20%, Experiment Performance: 30%, Attendance 10%, Viva: 40%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="5">Course Objective: To provide hands-on experience on digital and analog VLSI circuit design and to perform analysis of various types of antennas.</td></tr>
<tr><td>Sr. No.</td><td colspan="4">Contents</td></tr>
<tr><td>1.</td><td colspan="4">VLSI Design Lab:
1. Design and Implementation of combinational circuits:
Basic Gates, Half-Adder and Full-Adder, Half-Subtractor and Full-Subtractor, Decoder, Encoder, Parity Checker, Multiplexer, De-multiplexer, converter, comparator
Design and implementation of sequential circuits: Flip-flops, Counters, Shift registers
2. Simulation of CMOS inverter and measure its delay, noise margin, power. Design of a voltage reference and simple, cascade current mirror. Design & simulation of common source amplifier.</td></tr>
<tr><td>2.</td><td colspan="4">Antenna Lab:
1. Study of Microstrip Slot Antenna for UWB Applications
2. Performance Analysis of Microstrip Patch Antenna
3. Analysis of MIMO and Massive Antennas
4. Analysis of Different Feeding Mechanism of Antenna
5. Study of Implantable Antennas for Biomedical Applications.</td></tr>
<tr><td colspan="5">Course Outcomes (COs):
After successful completion of the course, students will be able to:
CO1: Design and analysis of various combinational and sequential VLSI circuits.
CO2: Design and analysis of various analog VLSI circuits.</td></tr>
</table>

CO3: Design and analysis of various types of antennas and their applications.

Text Books:

1. Sung-Mo Kang, Yusuf Liblebici, “CMOS Digital Integrated Circuits,” Tata McGraw Hill 2003.
2. Design of Analog CMOS Integrated Circuits, by BehzadRazavi, McGraw-Hill
3. Balanis, C.A., “Antenna Theory and Design”, 3rd Ed., John Wiley & Sons (2005).

PROGRAM ELECTIVES

Name of the Course	**Compound Semiconductors and RF Devices**		
Course Code	**MEC-2005**	**Credits-3**	**L-3, T-0, P-0**
Total Lectures	**3 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:
The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates:
Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objective: To provide knowledge of various compound semiconductor alloys, and their growth, properties, devices and applications.

Sections	Course Content
Section A	Optoand high frequency materials: Bonds, crytstal lattices, crystallographic planes and directions, direct and indirect semiconductors and their comparison for optical applications, optical processes of absorption and emission, radiative and non-radiative deep level transitions, phase and energy band diagrams of binary, ternary and quaternary alloys, determination of cross-over compositions and band structures.
Section B	High frequency devices: Gunn diode, RWH mechanism, v-E characteristic, formation of domains, modes of operation in resonant circuits, fabrication, control of v-E characteristics by ternary and quaternary alloys.
Section C	Heterostructures: Introduction, abrupt isotype/anisotype junctions, band diagrams and band off-sets, electrical and optoelectronic properties, symmetrical and asymmetrical p-n diodes and their characteristics, 2-Dimensional Electron Gas (2- DEG).
Section D	Heterostructure devices: HBT, MOSFET, HEMT, quantum well and tunneling structures, lasers, LED and photodetectors, optoelectronic IC's and strained layer structures.

Course Outcomes (COs):
After successful completion of the course, students will be able to:
CO1: Identify the various semiconductor alloys and implement their applications.
CO2: Understand the concepts of Lasers and LEDs.

Text Books:
1. C.Y. Chang, F. Kai, GaAs High-Speed Devices: Physics, Technology and Circuit Applications, Wiley & Sons.
2. Cheng T. Wang, Ed., Introduction to Semiconductor Technology: GaAs and Related Compounds, John Wiley & Sons.
3. David K. Ferry, Ed., Gallium Arsenide Technology, Howard W. Sams& Co., 1985
4. Avishay Katz, Indium Phosphide and Related materials: Processing, Technology and Devices, Artech House, 1992.

Reference Books:
1. S.M. Sze, High Speed Semiconductor Devices, Wiley 1990.

2. Sandip Tiwari, Compound Semiconductor Device Physics, Academic Press1991.

Name of the Course	**Flexible and Printed Electronics**		
Course Code	**MEC-2006**	**Credits-3**	**L-3, T-0, P-0**
Total Lectures	**3 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

Course Objectives: To understand the obstacles and initiatives in developing novel electronics devices tailored to the demands of the Flexible Hybrid Electronics (FHE) community. Grasp the complexities associated with scaling FHE, Alternative fabrication techniques.

Section	Course Content
Section A	Introduction: Introduction to Flexible electronics- Historical background - Materials, devices, systems, applications, printable electronics, stretchable electronics, wearable Electronics - Printable Flexible Hybrid Electronics (PFHE). Fabrication techniques - Unique aspects, status in the field and trends. Technologies of roll-to-roll printing, Printable electronics, Stretchable electronics, Wearable Electronics, Printing techniques, Various printing methods used in printed electronics, Potential level of printed electronics in the industry, area of applications of printed electronics.
Section B	Printing and Fabrication technology - Basics and fundamentals –Materials, processing and manufacturing, various semiconductors, dielectric and conducting materials, organic electronics, examples of printable functional materials gravure printing, screen printing, digital printing methods used in printed electronics, Printing techniques imprint lithography, spray pyrolysis, multilayer patterning, Fluid formation and rheology for printing - Inks and its types for printing –Conductive/semi-conductive inks Additional coating and structuring methods, different materials and their properties in printed electronics, paper-based electronics, textile substrates, Various printing/fabrication methods used in printed electronics.
Section C	Devices: Organic devices on flexible substrate, Principles and fundamentals- Sensors and biosensors, Examples of flexible physical, chemical and optical sensors, Actuators, flexible resistors, Other Flexible Devices and System Integration: Organic Light Emitting Diodes, Organic Solar Cells, thin flexible OLED displays, OLED lighting, smart wallpaper, sensors, logic, and memory, RFID tags, Latest applications of printed electronics, Encapsulation, Roll to roll printing processes, Integration Issues, and Designs for Future.

Section D	Future Trends of Flexible/Printable electronics technology: Alternative fabrication techniques - Laser processing - Additive manufacturing and advanced technologies used in printed electronics production for IoT, sensors, energy harvesting and other electronics devices, Examples of flexible super-capacitors and batteries, Further processing components - Interconnections, antennas, memories, future market and future prospects of printed electronics.

Course Outcomes (COs):

At the end of the course students will able to:

CO1: Delve into the basics of Printable Flexible Hybrid Electronics (PFHE) processing technologies.

CO2: Understand the Potential level of printed electronics in the industry and their needs.

CO3: Explore the realm of printed electronics and its potential applications within the industry.

CO4: Gain insight into diverse products within the printed electronics domain.

Text Books:

1. A G. Nisato, D. Lupo, S. Ganz (Editors) (2016), Organic and Printed Electronics: Fundamentals and Applications, CRC Press.
2. Large Area and Flexible Electronics, Mario Caironi & Yong-Young Noh (Editors (2015), WILEY-VCH.
3. Wong, William S., and Alberto Salleo, (Eds.) (2009) Flexible electronics: materials and applications. Vol. 11. Springer.
4. Suganuma Katsuaki, Introduction to Printed Electronics, Springer, 2014.

Reference Books:

1. M. M. Hussain and N. El-Atab, Handbook of Flexible and Stretchable Electronics, CRC Press, 2020.
2. Anna Köhler and Heinz Bässler, Electronics Processes in Organic Semiconductors - An Introduction, 1st Ed., Wiley-VCH, 2015.

<table>
<tr><td>Name of the Course</td><td colspan="3">Reliability of Electronic Devices</td></tr>
<tr><td>Course Code</td><td>MEC-2007</td><td>Credits-3</td><td>L-3, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">3 Hours/Week</td></tr>
<tr><td>Semester End</td><td>Max Marks:</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.</td></tr>
<tr><td colspan="4">Course Objectives: The course aims to understand the fundamental concepts of reliability; failure modes, mechanisms, and cost analysis of warranty returns. To understand the mathematical methods for reliability modelling and accelerated testing. Also to familiarize with the materials and processes used for semiconductor device packaging and develop proficiency in failure analysis techniques.</td></tr>
</table>

Section	Course Content
Section A	Background and Introduction: Definitions of reliability, failure modes, mechanisms, cost of warranty returns, motivation for improving product reliability in the era of ‘Planned Obsolescence. Introduction to mathematical methods for reliability: Failure rates, Normal distribution function, Six Sigma, Exponential, Weibull and Lognormal distributions for reliability modeling. Manufacturing yields.
Section B	Accelerated testing: Types of accelerated tests, Designing accelerated tests for typical stressors experienced in field, Acceleration factors, Arrhenius, Eyring and modified coffin-Manson models. Introduction to semiconductor device packaging: Materials and processes used for semiconductor device packaging, stresses induced because of packaging.
Section C	Physics of failure – based models for: Mass transport-induced failures (electromiration and stress voiding), Electronic charge-induced failures (Dielectric breakdown, Hot carrier effects, Electrical over-stress and Electrostatic discharge), Environmental damage (moisture ingress, corrosion, radiation damage), Degradation of interconnects (solder creep and fatigue).

Section D	Failure Analysis techniques: Non-destructive techniques – I-V trace, Infrared, X-ray and Electroluminescence imagining, Destructive techniques- chemical / thermal / mechanical decapsulation of electronic devices for die-level failure analysis, materials analysis techniques – FTIR, EDX. Special topics: Design for reliability, degradation in photovoltaic (PV) modules, systems reliability.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Understanding the fundamental concepts of reliability, failure modes, mechanisms, and cost analysis of warranty returns.

CO2: Proficiency in mathematical methods for reliability modeling and manufacturing yields.

CO3: Ability to design and execute accelerated tests for typical stressors experienced in the field.

Text Books:

1. Reliability and Failure of Electronic Materials and Devices by Milton Ohring, Lucian Kasprzak 2014.
2. Failure Analysis, A Practical Guide for Manufacturers of Electronic Components and Systems by Marius Bazu, TituBajenescu · 2011.

Reference Books:

1. Component Reliability for Electronic Systems ByTitu I. Băjenescu, Marius I. Bâzu · 2010.

Name of the Course	**Microstrip Antennas**		
Course Code	**MEC-2008**	**Credits-3**	**L-3, T-0, P-0**
Total Lectures	**3 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

Course Objectives: The objectives of this course are to provide general knowledge of the fundamental principles and concepts related with micro-strip patch antennas and circuits.

Section	**Course Content**
Section A	Micro-Strip Lines: Introduction of Planar Transmission Structures, Micro-strip Field Configuration, Micro-strip Dispersion Models, Micro-strip Transitions, Micro-strip measurement, Analysis, Analysis of an Open Micro-strip, Analysis of an Enclosed Microstrip, Design Considerations, Suspended and Inverted Micro-strip Lines, Multi-layered Dielectric Micro-strip, Thin Film Micro-strip (TFM), Valley Micro-strip Lines, Micro-strip Applications.
Section B	Micro-Strip Antenna Arrays: Array theory, Array calculations and analysis, array architectures, corporate array design, Resonant series fed array design, Series fed travelling wave array design.
Section C	Slot-Line: Introduction of Slot-lines, Slot-line Analysis, Design Considerations, Slot-line Discontinuities, Slot-line Transitions, Slot-line Applications.
Section D	Coupled Micro-Strip Lines: Introduction of Coupled Micro-strip Lines, General Analysis of Coupled Lines, Characteristics of Coupled Micro-strip Lines, Measurements on Coupled Microstrip Lines, Design Considerations for Coupled Micro-strip Lines, Coupled Multi conductor Micro-strip Lines, Discontinuities in Coupled Micro-strip Lines

Course Outcomes (COs):
After successful completion of the course, students will be able to:

CO1: Ability to understand the basic concept of micro-strip antennas, methods of analysis and configurations.
CO2: Ability to understand micro-strip antennas arrays.
CO3: To understand the significance of different micro-strip feed mechanism available.
CO4: Ability to understand coupled micro-strip line with multiband and broadband behavior.

Text Books:

1. Gupta, K.C. and Garg, Ramesh, Micro-strip lines and slot lines, Artech house (1996).
2. Sainiti, Robert A., CAD of Micro-strip Antenna for Wireless Applications, Artech House(1996).

Reference Books:

1. Lu, Wong Kim, Planar antennas for Wireless applications, John Wiley and Sons (2003).
2. Simons, Rainee N., Coplanar Waveguide Circuits, Components, and Systems, John Wiley and Sons (2001).

Name of the Course	**Low Power CMOS VLSI Design**			
Course Code	**MEC-2009**	**Credits-3**	**L-3, T-0, P-0**	
Total Lectures	**3 Hours/Week**			
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**	
Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**	
Instructions				
For Paper Setters: The question paper will consist of five sections A, B, C, D and E. Section E will be Compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C and D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.				
For Candidates: Candidates are required to attempt five questions in all selecting one question from each of the section A, B, C and D of the question paper and all the subparts of the questions in section E. Use of non-programmable calculators is allowed.				
Course objective: To provide in-depth knowledge of the low power VLSI circuits and a basic idea on different low power circuit design techniques.				

Sections	**Course Content**
Section A	Introduction: Introduction to Low Power VLSI design, Importance of low power design, Challenges in low power VLSI design, Application of Low Power VLSI circuits, Power analysis of CMOS circuits, Themes of Low Power VLSI design, Supply voltage scaling, Reduction of load capacitances.
Section B	Low Voltage Process Technology: CMOS device structure and process fabrication, Innovation on process technology for low power consumption, Multi-threshold process technology, Latch up problem in CMOS technology, Discussion on SPICE Models of MOS transistor, MOS Capacitances, CMOS Low voltage analytical model, Threshold voltage definitions, Different Short Channel Effects.
Section C	Techniques for low power design at Logic Design Level: CMOS logic design style, CMOS Inverter design, Transfer characteristics of CMOS inverter, Delay calculation of CMOS Logic gates, Analysis of various logic design styles for their power consumption (CPL, Domino Logic, NORA CMOS, TSPC Logic, DCVSL, etc.).
Section D	Low power design techniques at Architecture and System Level: Importance of parallelism, Introduction to Pipelining, Low power design utilizing redundancy and Data Encoding, Importance of Regularity and Locality, Reduction of complexity to improve power consumption, Low power design techniques at system level.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Able to carry out research and development in the area of Low Power VLSI circuits.

CO2: Apply techniques to improve power consumption of VLSI circuits.

CO3: Utilize logic simulation methods to design Low Power VLSI circuits.

CO4: Apply logic-level, architecture-level and system-level techniques in various designs to optimize power consumption of the VLSI circuits.

Text Books:

1. A.P.Chandrakasan and R.W.Broderson, Low Power CMOS Design, IEEE Press, 1998.
2. A. Bellaouar and M. I. Elmasry, Low Power Digital VLSI Design Circuits and Systems, Springer.
3. Gary Yeap, "Practical Low Power Digital VLSI Design", Springer Science + Business Media, LLC.

Reference Books:

1. Jan M. Rabaey, MassoudPedram, Low Power Design Methodologies, Springer Science + Business Media,LLC**.**
2. Ajit Pal, Low-Power VLSI Circuits and Systems, Springer.

<table>
<tr><td>Name of the Course</td><td colspan="3">Advanced Computer Networks and Protocols</td></tr>
<tr><td>Course Code</td><td>MEC-2010</td><td>Credits-3</td><td>L-3, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">3 Hours/Week</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.</td></tr>
<tr><td colspan="4">Course Objectives: This course aims to provide advanced background on relevant computer networking topics to have a comprehensive and deep knowledge in computer networks.</td></tr>
</table>

Section	Course Content
Section A	Review of Computer Networks, Devices and the Internet: Internet, Network edge, Network core, Access Networks and Physical media, ISPs and Internet Backbones, Delay and Loss in Packet-Switched Networks, Networking and Internet - Foundation of Networking Protocols: 5-layer TCP/IP Model, 7-Layer OSI Model, Internet Protocols and Addressing. Multiplexers, Modems and Internet Access Devices, Switching and Routing Devices, Router Structure. The Link Layer and Local Area Networks-Link Layer, Introduction and Services, Error- Detection and Error-Correction techniques, Multiple Access Protocols, Link Layer Addressing, Ethernet, Interconnections: Hubs and Switches, PPP: The Point-to-Point Protocol, Link Virtualization.
Section B	Data-link protocols: Ethernet, Token Ring and Wireless (802.11). Wireless Networks and Mobile IP: Infrastructure of Wireless Networks, Wireless LAN Technologies, IEEE 802.11 Wireless Standard, Cellular Networks, Mobile IP, Wireless Mesh Networks (WMNs), Multiple access schemes .
Section C	Routing and Internetworking: Network–Layer Routing, Least-Cost-Path algorithms, Non-Least-CostPath algorithms, Intra-domain Routing Protocols, Inter-domain Routing Protocols, Congestion Control at Network Layer. Logical Addressing: IPv4 Addresses, IPv6 Addresses - Internet Protocol: Internetworking, IPv4, IPv6, Transition from IPv4 to IPv6 – Multicasting Techniques and Protocols: Basic Definitions and Techniques, Intra-domain Multicast Protocols, Inter-domain Multicast Protocols, Node-Level Multicast algorithms.

Section D	Transport and Application Layer Protocols: Client-Server and Peer-To-Peer Application Communication, Protocols on the transport layer, reliable communication. Routing packets through a LAN and WAN. Transport Layer, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Mobile Transport Protocols, TCP Congestion Control. Principles of Network Applications, The Web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, Domain Name System (DNS), P2P File Sharing, Socket Programming with TCP and UDP, Building a Simple Web Server.

Course Outcomes (COs):

At the end of the course students will able to:

CO1: Analyze the functionality of the Network Models and the working of the Network Devices.

CO2: Identify various error detection and error correction techniques applied in Computer Networks.

CO3: Explore various IEEE Standards for wired and wireless Networks along with Multiple Access schemes.

CO4: Analyze the working of intra and inter domain routing protocols.

Text Books:

1. Computer Networking: A Top-Down Approach, James F. Kuros and Keith W. Ross, Pearson, 6th Edition,2012 .
2. A Practical Guide to Advanced Networking, Jeffrey S. Beasley and Piyasat Nilkaew, Pearson, 3rd Edition,2012

Reference Books:

1. Computer Networks , Andrew S. Tanenbaum, David J. Wetherall, Prentice, 5th Edition,2010

<table>
<tr><td>Name of the Course</td><td colspan="3">Sensor Technology and MEMS</td></tr>
<tr><td>Course Code</td><td>MEC-2011</td><td>Credits-4</td><td>L-3, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">3 Hours/Week</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators isallowed.</td></tr>
<tr><td colspan="4">Course Objectives:In this course the students will learn basic concept of MEMS devices, their working principles, equivalent circuits, different MEMS sensors, fabrication technologies, modelling and characterization tools.</td></tr>
</table>

Sections	Course Content
Section A	Introduction to MEMS: Introduction to MEMS and Micro sensors, MEMS system-level design methodology, Equivalent Circuit representation of MEMS, Signal Conditioning Circuits. MEMS Foundry processes: CMOS-MEMS Integration: Design and technology, MEMS reliability, non-silicon MEMS, Principles of Physical and Chemical Sensors: Sensor classification, Sensing mechanism of Mechanical, Electrical, Thermal, Magnetic, Optical, Chemical and Biological Sensors.
Section B	Sensor Technology: Concept of clean room, Vacuum systems, Thin Film Materials and processes (Lithography, oxidation, sputtering, diffusion, CVD, micro machining, Wafer bonding, Wire bonding and Packaging.
Section C	Sensor Modelling: Numerical modelling techniques, Model equations, different effects on modelling (mechanical, electrical, thermal, magnetic, optical, chemical and biological and example of modelling. Sensor characterization and Calibration: Basic measurement and characterization systems, study of static and dynamic Characteristics, Sensor reliability, Ageing Test, failure mechanism.
Section D	Sensor Applications: Pressure Sensor with embedded electronics, Accelerometer, RF MEMS Switch with electronics, Bio-MEMS, environmental monitoring (Gas Sensors). Future Aspects of MEMS: NEMS, MOEMS, Bio-MEMS, RF MEMS, Optical MEMS.

Course Outcomes (COs):

After completion of the course, students will be able to:

CO1: Acquire knowledge about MEMS & Micro Sensors.

CO2:Understand the basic concept of MEMS Fabrication Technologies, Design and technology and CMOS-MEMS Integration

CO3:Understand the basic concept of MEMS sensors modelling

CO4:Acquire knowledge about Future aspects of MEMS and its application

Text Books:

1. Franssila, Sami, Introduction to Micro fabrication, John Wiley & Sons, (2010) 2nded.
2. Gad-el-Hak, Mohamed, MEMS: Introduction and Fundamentals, CRC Press (2005)2nded.
3. Maluf, N., An Introduction to Micro-Electro-Mechanical Systems Engineering, ArtechHouse(2000).
4. Ristic, L. (Editor), Sensor Technology and Devices, ArtechHouse(1994).

Reference Books:

1. Baltes, Brand, Fedder, Hierold, Kowenk, Tabata, Advanced Micro and Nanosystems, Vol. 1, Enabling Technology for MEMS and Nanodevices,Wiley,VCH, 2004.
2. Leondes, T.C., MEMS/NEMS Handbook: Techniques and Applications, Springer Press(2007). 6. Senturia, S. D., Microsystem Design, Springer(2004).

Name of the Course	**Design for IOT**		
Course Code	**MEC-2012**	**Credits-3**	**L-3, T-0, P-0**
Total Lectures	**3 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

Course Objectives: Students will be able to understand the concepts of Internet of Things (IoT) and can able to build IoT based applications.

Section	**Course Content**
Section A	Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models &APIs IoT& M2M: Machine to Machine, Difference between IoT and M2M, Software define Network Sensors and Actuators modules: Concept, layout, working and applications of different sensors and actuators: temperature sensor, motion sensor LDR sensors, IR sensor, Ultrasonic sensor, Relay etc.
Section B	Embedded Systems for IoT Introduction to Arduino Programming, Arduino interfacing with sensors and actuators, IoT based actuator operation using Arduino, Introduction to R-pi and its Programming, R-pi hardware interfacing and applications, Smartphone interfacing with R-pi, Wi-Fi module interfacing with R-pi and associated applications.
Section C	Network and Communication Protocol: Wireless medium access issues, MAC protocol survey, Constrained Application Protocol (CoAP), Message Queue Telemetry Transport Protocol (MQTT), Sensor deployment & Node discovery, Data handling and analytics, Cloud platform for IoTs,.
Section D	Developing IoT based Systems: Experiments with Arduino Hardware and sensor interfacing procedures. Automatic lighting control using IoT, home automation, connected health, smart farming, industry applications, connected vehicles, smart city, and developing sensor based application through embedded system platform. Introduction to Python, Implementing IoT concepts with python Challenges in IoT: Design challenges, Development challenges, Security challenges, other challenges.

Course Outcomes (COs):

Upon successful completion of the course, the students will be able to:

CO1: Recognize the concepts of Internet of Things.

CO2: Demonstrate the interfacing of different sensors and actuators modules with embedded systems.

CO3: Analyze basic protocols in wireless sensor network.

CO4: Design IoT applications in different domain and be able to analyze their performance.

Text Books:

1. Vijay Madisetti, Arshdeep Bahga, “Internet of Things: AHands- On Approach” .
2. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things” John Wiley (2014)1sted.

Reference Books:

1. Hanes David, Salgueiro Gonzalo, Grossetete Patrick, Barton Rob, Henry Jerome,” IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things”, Pearson(2016).
2. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", John Wiley &Sons,Ltd(2011).

<table>
<tr><td>Name of the Course</td><td colspan="3">Computational Electromagnetics</td></tr>
<tr><td>Course Code</td><td>MEC-2013</td><td>Credits-3</td><td>L-3, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">3 Hours/Week</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Sections A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester-end examination for the course.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.</td></tr>
<tr><td colspan="4">Course Objectives: The objective of the course is to develop the skills required to solve problems related to electrostatics, magnetostatics, microwaves, and optical waves using computational methods.</td></tr>
</table>

Section	Course Content
Section A	Review of Basic Electromagnetics: Electrostatics, Magnetostatics, Wave equations, TE, TM and Hybrid modes, Guided wave structures, Metallic waveguides, Dielectric waveguides, Radiating structures Applications of electromagnetics, Historical development of Computational. Numerical Methods: ODE solvers, Euler, Runge-Kutta, Boundary conditions, Propagation of errors, Survey of numerical packages.
Section B	Finite difference time domain method: An overview of finite differences time domain method, the 1D, 2D & 3D FDTD algorithm, obtaining wideband data using the FDTD, Numerical dispersion in FDTD simulations, The PML absorbing boundary condition, and Commercial implementations.
Section C	Method of moments (MoM):An overview of the Method of Moment (MoM), Thin-wire electrodynamics, and the MoM more on basis functions, the method of weighted residuals.
Section D	Finite Element Method (FEM): Introduction of Finite element method, Variational and Galerkin weighted residual formulations: the Laplace equation, Simplex coordinates, high-frequency variational functional, Spurious modes, Vector (edge) elements, Application to waveguide eigen value analysis, The three- dimensional Whitney element, The time domain FEM.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Acquire knowledge about the history and application of computational electromagnetic.

CO2: Acquire knowledge about different computational electromagnetic techniques.

CO3: Solve the electromagnetic problem using computational techniques.

Text Books:

1. Balanis, C.A., "Antenna Theory and Design", 3rd Ed., John Wiley & Sons (2005).
2. G Jordan, E.C., and Balmain, K.G., "Electromagnetic Waves and Radiating Systems", 2nd Ed., Prentice-Hall of India.
3. David B. Davidson, Computational Electromagnetics for RF and microwave engineering, Cambridge University Press2005

Reference Books:

1. Dennis M. Sullivan, Electromagnetic simulation using the FDTD method.

<table>
<tr><td>Name of the Course</td><td colspan="3">Deep Learning for Computer Vision</td></tr>
<tr><td>Course Code</td><td>MEC-2014</td><td>Credits-3</td><td>L-3, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">3 Hours/Week</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.</td></tr>
<tr><td colspan="4">Course Objectives: The course aims to provide exposure to the students on the advances in deep learning theories and their applications to real life problems.</td></tr>
</table>

Section	Course Content
Section A	Fundamentals of Machine Learning: Learning, Under fitting, Over fitting, Estimators, Bias, Variance, Maximum likelihood estimation, Bayesian Statistics, Supervised learning, Unsupervised learning, Reinforcement learning,
Section B	Practical Aspects of Deep Learning: Bias and Variance, Over and under fitting, Regularization, Dropout Regularization, Normalizing, Vanishing and Exploding Gradients, Weight Initialization Optimization: Mini-batch Gradient Descent, Exponentially Weighted Averages, Bias Correction in Exponentially Gradient Descent with Momentum, RMSProp, Adam Optimization Algorithm, Learning Rate Decay, Hyperparameters Tuning in Practice, Normalizing Activations in a Network, Softmax Regression, Training a Softmax Classifier.
Section C	Introduction to CNN: Computer Vision, Edge Detection, Padding, Strided Convolution, Convolution over Volume, One Layer Convolution Network, Pooling and Fully Connected Layer, Transfer Learning, Data Augmentation. Classical CNN: LeNet, VGG16, ResNet, 1x1 Convolution, Inception Network, Mobile Net, Efficient Net
Section D	Object Detection: Object Localization, Landmark Detection, Object Detection, Convolution Implementation of Sliding, Window, Bounding Box Prediction, Intersection over Union, Non-max Suppression, Anchor Boxes, YOLO, Algorithm, Semantic Segmentation with U-Net, Transpose Convolution, U-Net Architecture.

	Face Recognition: Face recognition, One Shot Learning, Siamese Network, Triplet Loss, Face Verification, Neural Style, Transfer, Deep Convet Learning, Content Cost Function, Style Cost Function.

Course Outcomes (COs):

At the end of the course students will able to:

CO1: Build and train deep neural networks and apply optimization algorithms.
CO2: Identify architecture parameters, and apply DL to your applications.
CO1: Apply CNN to visual detection and recognition tasks.
CO2: Apply deep learning specific open source libraries for solving real life problems.

Text Books:

1. Goodfellow L., Bengio Y. and Courville A., Deep Learning, MIT Press (2016).
2. Patterson J.,Deep Learning: A Practitioner's Approach, O'Reilly (2017), 1st ed.
3. Neural Networks and Deep Learning by Michael Nielsen.
   http://neuralnetworksanddeeplearning.com

Reference Books:

1. Haykin S., Neural Network and Machine Learning, Prentice Hall Pearson (2009), 3rd ed.
2. Geron A., Hands-on Machine Learning with Sci-kit and Tensor Flow, O'Reilly Media (2017).

<table>
<tr><td>Name of the Course</td><td colspan="3">Analog & Mixed Signal Circuit Design</td></tr>
<tr><td>Course Code</td><td>MEC-2015</td><td>Credits-3</td><td>L-3, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">3 Hours/Week</td></tr>
<tr><td>Semester End</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.</td></tr>
<tr><td colspan="4">Course Objectives: The objective of this course is to provide the basic knowledge of analog and mixed signal circuits and their performance parameters.</td></tr>
</table>

Section	Course Content
Section A	Introduction to Mixed Signal: Device Models, IC Process for Mixed Signal, Concepts of MOS Theory. Analog MOS Process: Analog CMOS Process (Double Poly Process), Digital CMOS Process tailored to Analog IC fabrication, Fabrication of active devices, passive devices and interconnects, Analog Layout Techniques, Symmetry, Multi-finger transistors, Passive devices: Capacitors and Resistors, Substrate Coupling, Ground Bounce.
Section B	Amplifiers and Current sources: Large Signal and Small-Signal analysis of common source stage, Source Follower, Common Gate Stage, Cascode, Folded Cascode, differential amplifier, current Sources, Basic Current Mirrors, Cascode Current Mirrors and current mirror based differential amplifier, op-Amp.
Section C	Comparators: Circuit Modeling, Auto Zeroing Comparators, Differential Comparators, Regenerative Comparators, Fully Differential Comparators, Latched Comparator. Data Converters: Requirements, Static and Dynamic Performance, SNR and BER, DNL, INL.

Section D	High Speed A/D Converter Architectures: Flash, Folding, Interpolating, piplelined. High Speed D/A Converter Architectures: Nyquist-Rate D/A Converters, Thermometer Coded D/A Converters, Binary Weighted D/A Converters.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1:Acquire a basic knowledge of analog and mixed signal circuit design.

CO 2: Design of single stage and differential stage amplifiers with and without current mirror circuits, respectively.

CO 3:Use the techniques and skills for design and analysis of CMOS based switched capacitor circuits and comparator.

CO 4 :Analyze the performance of A/D and D/A converter architectures

Text Books:

1. Razavi, B., Design of Analog CMOS Integrated Circuits, Tata McGraw Hill(2008).
2. Gray,P.R.,Hurst,P.J.,Lewis,S.H.,andMeyer,R.G.,AnalysisandDesignofAnalogIntegratedCircuits, John Wiley (2001)5thed.

Reference Books:

1. Allen, P.E. and Holberg, D.R., CMOS Analog Circuit Design, Oxford University Press (2002) 2^{nd} edition.

Name of the Course	**VLSI Interconnects**		
Course Code	**MEC-2016**	**Credits-3**	**L-3, T-0, P-0**
Total Lectures	**3 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:
The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates:
Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objective: To provide in depth knowledge of interconnect modeling and performance analysis; introduction and analysis of futuristic material based interconnects such GNRs, CNTs and fiber optics.

Sections	**Course Content**
Section A	Preliminary concepts: Interconnects for VLSI applications, metallic interconnects, optical interconnects, superconducting interconnects, advantages of copper interconnects, challenges posed by copper interconnects, fabrication process, even and odd mode capacitances, miller theorem, transmission line equations, resistive interconnection as ladder network, propagation modes in microstrip interconnection, slow wave mode propagation, propagation delays.
Section B	Parasitic extraction: Parasitic resistance, effect of surface/interface scattering and diffusion barrier on resistance, Capacitance: parallel-plate capacitance, fringing capacitance, coupling capacitance, methods of capacitance extraction, Inductance: self-inductance, mutual inductance, methods of inductance extraction, high frequency losses, frequency dependent parasitics, skin effect, dispersion effect.
Section C	Modeling of interconnects and Crosstalk analysis: Elmore model, Transfer function model, even and odd mode model, Time domain analysis of multiconductor lines, Finite Difference Time Domain (FDTD) method, performance analysis using linear driver (Resistive) and nonlinear driver (CMOS), advanced interconnect techniques to avoid crosstalk.
Section D	Future VLSI Interconnects: Optical interconnects, Superconducting interconnects, Nanotechnology interconnects, Silicon nanowires, Carbon nanotubes, Graphene nano ribbons: system issues and challenges, material processing issues and challenges, design issues and challenges.

Course Outcomes (COs):
After successful completion of the course, students will be able to:

CO1: Understand the concepts of VLSI interconnects and its applications.

CO2: Apply interconnect models and perform its analysis

Text Books:

1. High-Speed VLSI Interconnects, Ashok K. Goel 2007.

Reference Books:

1. Advanced Nanoscale ULSI Interconnects: Fundamentals and Applications, Y.S. Diamand 2009.
2. Carbon nanotube and Graphene Device Physics, H.S Philip Wong and Deji Akinwande 2011.

Name of the Course	**Nanoscale Devices**		
Course Code	**MEC-2017**	**Credits-3**	**L-3, T-0, P-0**
Total Lectures	**3 Hours/Week**		
Semester End Examination	**Max Marks: 100**	**Min. Pass Marks: 40**	**Max. Time: 3 Hrs.**
Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 50**

Instructions

For Paper Setters:
The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates:
Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objective: To instigate fundamental concepts of solid state physics and basic semiconductor devices.

Sections	Course Content
Section A	Long Channel MOSFETs: History; Introduction – MOSFET as a barrier controlled device; MOSFET I-V characteristics; Drain current models, MOSFET scaling; subthreshold characteristics; substrate bias and temperature dependence, MOSFET electrostatics – energy band picture, 1D electrostatic Poisson-Boltzmann equation, depletion approximation, onset of inversion, gate voltage and surface potential, static and mobile charges.
Section B	Short Channel Effects: Charge sharing; channel length modulation; DIBL; GIDL; velocity saturation; MOSFET breakdown; concepts of high-K/metal gate; Advanced planar and 3D transistors: SOI, FDSOI, DG-ETSOI; FINFETs, nanowires.
Section C	Nanoscale transport: Bottom-up approach, Landauer's formalism, Ballistic and diffusive transport – modes, IV characteristics, conductance, voltage drop and heat dissipation, ballistic MOSFET, ballistic injection velocity, Virtual Source Model,
Section D	Current topics and open issues: Strained Si technology, NEGF, Thermoelectric effects and thermoelectric devices, Quantum dot devices – quantum capacitance, IV characteristics, self-consistent method.

Course Outcomes (COs):
After successful completion of the course, students will be able to:

CO1: Apply the concepts of solid state physics and basic semiconductor devices.

CO2: Understand and apply the concepts of MOSFETs

Text Books:

1. Mark Lundstorm, "Fundamentals of Nano transistors," World Scientific. 2016.
2. Tak H. Ning and Yuan Taur, "Fundamentals of Modern VLSI Devices" Pearson Education India Pvt. Ltd. 2015.

Reference Books:

1. Donald A. Neamen, “Semiconductor Physics and Devices”, McGraw Hill Higher Education 2002.
2. S. M. Sze and Kwok K. Ng, “Physics of Semiconductor Devices,” Wiley 2008.

<table>
<tr><td>Name of the Course</td><td colspan="3">Biomedical Electronics</td></tr>
<tr><td>Course Code</td><td>MEC-2018</td><td>Credits-3</td><td>L-3, T-0, P-0</td></tr>
<tr><td>Total Lectures</td><td colspan="3">3 Hours/Week</td></tr>
<tr><td>Semester End Examination</td><td>Max Marks: 100</td><td>Min. Pass Marks: 40</td><td>Max. Time: 3 Hrs.</td></tr>
<tr><td colspan="3">Continuous Assessment (Based On Sessional Tests (2) 50%, Tutorials / Assignments 30%, Quiz/Seminar 10%, Attendance 10%)</td><td>Max Marks: 50</td></tr>
<tr><td colspan="4">Instructions</td></tr>
<tr><td colspan="4">For Paper Setters:
The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.</td></tr>
<tr><td colspan="4">For Candidates:
Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.</td></tr>
<tr><td colspan="4">Course Objectives: The course aims to teach fundamentals of biomedical processes of human body. Also to provide an insight into use of the biomedical equipment for monitoring human body problems.</td></tr>
</table>

Section	Course Content
Section A	Characteristics of Transducers and Electrodes for Biological Measurement, Introduction to human body, block diagram, classification, characteristics, various physiological events and suitable transducer for their recording, bioelectric potentials. Recent Trends in Biomedical Engineering, Patient care and monitoring, Non-invasive diagnostic instrumentation, Biotelemetry, Telemedicine, Prosthetic devices, Lie detector test, Application of lasers and ultrasonic in biomedical field.
Section B	Cardiac System, Cardiac musculature, Electro cardiography, ECG recording, Phonocardiography, ECG lead system, Heart rate meter, vector cardiography, Defibrillators. Blood Pressure and Blood Flow Measurement, Invasive and non-invasive methods of Blood pressure, Characteristics of blood flow and heart sound, Cardiac output measurement, Plethysmography.
Section C	Respiratory System, Mechanics of breathing, Parameters of respiration, Respiratory system measurements, Respiratory therapy instruments. Instrumentation for Measuring Nervous Function, EEG signal, frequency band classification, Lead systems, EEG recording, Clinical applications of EEG signal, X-ray CT scan, MRI, PET.
Section D	Recent Trends in Biomedical Engineering, Patient care and monitoring, Non-invasive diagnostic instrumentation, Biotelemetry, Telemedicine, Prosthetic devices, Lie detector test, Application of lasers and ultrasonic in biomedical field.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Identify the various biomedical processes and problems associated with human body.

CO2: Apply principles of electronics and instrumentation to cope up with biomedical processes.

CO3: Assess and analyze the performance of biomedical electronic devices and signal processing.

Text Books:

1. Introduction to Bio-medical Instrumentation by R.S. Khandpur, McGraw Hill Education.
2. Bio Medical Instrumentation by Cromwell, Prentice Hall India Learning Private Limited.

Reference Books:

1. John G. Webster, Medical Instrumentation, Application and Design. John Wiley, 3rd

Admission & Eligibility Criteria for M. Tech Admissions

1. The admission process and eligibility criteria for the Master of Technology (M. Tech.) in Electronics & Communication Engineering program shall be in accordance with the norms prescribed by the All India Council for Technical Education (AICTE), which are as follows:

    - B. Tech./B.E./AMIE in Electronics & Communication Engineering/ Electronics & Instrumentation. Engineering/Applied Electronics/Instrumentation & Control Engineering//Electrical & Electronics Engineering/M. Sc. in Physics (with specialization in Electronics) or equivalent discipline consistent with research areas of the department with 55% marks (50% for SC/ST/PC candidates) marks in qualifying examination.

2. Admission to the M.Tech. program shall be based on the merit of the UG degree or the merit of an entrance test conducted by H.P. University Shimla.
3. The total number of student intake shall be 18, plus supernumerary seats as per HPU norms.
4. The entrance test will be based on Multiple Choice Questions (MCQ) with a total of 100 marks, each question carrying one mark. There will be no negative marking.

Course Duration

The Master of Technology shall be of two (02) year duration, spread over four (04) semesters and shall be run-on Full-Time basis. Further, the maximum duration of M.Tech course is five years.

Entrance exam Syllabus
Electronics & Communication Engineering [ECE]

Section 1: Engineering Mathematics

Linear Algebra: Vector space, basis, linear dependence and independence, matrix algebra, Eigen values and eigen vectors, rank, solution of linear equations- existence and uniqueness.

Calculus: Mean value theorems, theorems of integral calculus, evaluation of definite and improper integrals, partial derivatives, maxima and minima, multiple integrals, line, surface and volume integrals, Taylor series.
Differential Equations: First order equations (linear and nonlinear), higher order linear differential equations, Cauchy's and Euler's equations, methods of solution using variation of parameters, complementary function and particular integral, partial differential equations, variable separable method, initial and boundary value problems.

Vector Analysis: Vectors in plane and space, vector operations, gradient, divergence and curl, Gauss's, Green's and Stokes' theorems.

Complex Analysis: Analytic functions, Cauchy's integra theorem, Cauchy's integra formula, sequences, series, convergence tests, Taylor and Laurent series, residue theorem.

Probability and Statistics: Mean, median, mode, standard deviation, combinatorial probability, probability distributions, binomial distribution, Poisson distribution, exponential distribution, normal distribution, joint and conditional probability.

Section 2: Networks, Signals and Systems

Circuit Analysis: Node and mesh analysis, superposition, Thevenin's theorem, Norton's theorem, reciprocity. Sinusoidal steady state analysis: phasors, complex power, maximum power transfer. Time and frequency domain analysis of linear circuits: RL, RC and RLC circuits, solution of network equations using Laplace transform.
Linear 2-port network parameters, wye-delta transformation.

Continuous-time Signals: Fourier series and Fourier transform, sampling theorem and applications.

Discrete-time Signals: DTFT, DFT, z-transform, discrete-time processing of continuous-time signals. LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeroes, frequency response, group delay, phase delay.

Section 3: Electronic Devices

Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors.

Carrier Transport: diffusion current, drift current, mobility and resistivity, generation and recombination of carriers, Poisson and continuity equations.
P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell.

Section 4: Analog Circuits

Diode Circuits: clipping, clamping and rectifiers.

BJT and MOSFET Amplifiers: biasing, ac coupling, small signal analysis, frequency response. Current mirrors and differential amplifiers.
Op-amp Circuits: Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers and oscillators.

Section 5: Digital Circuits

Number Representations: binary, integer and floating-point- numbers. Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders.

Sequential Circuits: latches and flip-flops, counters, shift-registers, finite state machines, propagation delay, setup and hold time, critical path delay.

Data Converters: sample and hold circuits, ADCs and DACs. Semiconductor Memories: ROM, SRAM, DRAM.

Computer Organization: Machine instructions and addressing modes, ALU, data-path and control unit, instruction pipelining.

Section 6: Control Systems

Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag- lead compensation; State variable model and solution of state equation of LTI systems.

Section 7: Communications

Random Processes: auto correlation and power spectral density, properties of white noise, filtering of random signals through LTI systems.

Analog Communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, super heterodyne receivers.

Information Theory: entropy, mutual information and channel capacity theorem.

Digital Communications: PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, MAP, ML detection, matched filter receiver, SNR and BER. Fundamentals of error correction, Hamming codes, CRC.

Section 8: Electromagnetics

Maxwell's Equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector.

Plane Waves and Properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth.

Transmission Lines: equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart.
Rectangular and circular waveguides, light propagation in optical fibers, dipole and monopole antennas, linear antenna arrays.