PG-Curriculum
(Structure and Course Contents)
VLSI Design

With effect from July 2018

EXPLORE INNOVATE EXCEL

PUNJAB ENGINEERING COLLEGE (DEEMED TO BE UNIVERSITY)
CHANDIGARH

Electronics Engineering Department
Punjab Engineering College
(Deemed to be University)
Chandigarh

PG Curriculum Structure

(Semester I)

S. No.	Course Stream	Course Code	Course Name	Segment {Fractal systems (each section of 0.5 credits and 7 contact hours)}						Credits
				1	2	3	4	5	6	
1.	Soft Computing		Internet of things	■	■	■				1.5
			Machine Learning				■	■	■	1.5
2.	Design of Experiments and Research Methodology		Design of Experiments and Research Methodology (DE)	■	■	■	■	■	■	3
3.	Program Core-I		Electronic System Design	■	■	■	■	■	■	3
4.	Program Core-II		Digital VLSI Design	■	■	■	■	■	■	3
5.	Program Elective :E1		• Low Power Techniques • Microwave Integrated Circuit • RF and Microwave MEMS-I • FPGA and ASIC • Semiconductor Memories	■	■	■				1.5
	Program Elective :E2		• Low Power Subsystem Design • Semiconductor Microwave Devices • RF and Microwave MEMS-II • FPGA Based System Design • Memory Design & Testing				■	■	■	1.5
6.	Engineering mathematics		**EM1:** Fourier Transform	■	■					1
			EM2: Numerical Methods			■	■			1
			EM3: Optimization Techniques II					■	■	1
Total										18

(Semester-II)

Sr. No	Course Stream	Course Code	Course Name	Segment {Fractal systems (each section of 0.5 credits and 7 contact hours)}						Credits
				1	2	3	4	5	6	
1.	Soft skills & Management		Communication Skills (CS)							1.5
			Management and Entrepreneurship/ IPR							1
			Professional Ethics							0.5
2.	Program Core-III		Computer Aided VLSI Design							3
3.	Program Core -IV		Testing and Fault Tolerance							3
4.	Program Elective-E-3		• Real Time Systems • Semiconductor Device Modeling • Thin Film Deposition and Device Fabrication-I • Analog CMOS Design-I							1.5
	Program Elective-E-4		• Real Time Embedded Systems • Nanoelectronic Devices • Thin Film Deposition and Device Fabrication-II • Analog CMOS Design-II							1.5
5.	Open Elective**		*Open Elective 1* • Neural Networks							1.5
			Open Elective 2 • Applications of Neural Networks							1.5
6.	Mini Project/Pre - Dissertation									3
	Total									**18**

Summer Term

After examination of 2nd semester in the first week of summer vacation Industry visit can be undertaken.

S.No.	Course Code	Course Name	Credits
1.		Industrial visit (3 days to one week of visit, submission and presentation of visit report)	Satisfactory/Not-satisfactory

(Semester III)

S. No.	Course Code	Course Name	LTP	Credits
1.		Dissertation-I	0-0-32	16
Total				16

(Semester IV)

S. No.	Course Code	Course Name	LTP	Credits
1.		Dissertation-II	0-0-32	16
Total				16

Total Credits-68

- ***20% courses/ semester can be offered in blended mode MOOC's/Industry.***
- ***MOOC's/Industry offered course is having fractional credits. Industry offering course content will be designed by industry will be as per expert availability. Industry person will deliver and evaluate this subject. As per the duration of MOOC's/industry offered course, credits of this course can be decided (fractional credits).***

Course Name	**:**	**Internet of Things**
Course Code	**:**	**SCM5011**
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**1-3**

Total No. Lectures: 14
Total No. of Lab hrs. 14

Course Objectives:

The main objectives of this course are:

- To understand IoT architecture and market perspective.
- To understand the basic principles and operation of different types of sensors commonly used on mobile platforms.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Introduction to IOT** What is IoT, how does it work? Difference between Embedded device and IoT device, Properties of IoT device, IoT Ecosystem, IoT Decision Framework, IoT Solution Architecture Models, Major IoT Boards in Market , Privacy issues in IOT	2
2.	**Setting Up Raspberry Pi/Arduino to Create Solutions** Explore Raspberry Pi, Setting up Raspberry Pi, Showing working of Raspberry Pi using SSH Client and Team Viewer, Understand Sensing actions, Understand Actuators and MEMS.	3
3.	**Communication Protocols used in IoT** Types of wireless communication, Major wireless Short-range communication devices, properties, comparison of these devices (Bluetooth, WIFI, ZigBee, 6LoWPAN), Major wireless Long-range communication devices, properties, comparison of these devices (Cellular IoT, LPWAN)	3
4.	**IoTApplications** IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications	3
5.	**Sensors** Applications of various sensors: Google Maps, Waze, WhatsApp, Ola Positioning sensors: encoders and accelerometers, Image sensors: cameras Global positioning sensors: GPS, GLONASS, IRNSS, Galileo and indoor localization systems, Motion & Orientation Sensors: Accelerometer, Magnetometer, Proximity Sensor, Gyroscope, Calibration, - noise modelling and characterization, and - noise filtering and sensor data processing, Privacy & Security, Selection of Sensors for Practical Applications	3

Lab Work:

Sr. No.	Lab contents	No. of Hours
1.	Setting up Raspberry Pi and Arduino	2
2.	Build small scale wireless communicating IOT device	4
3.	Integrate positioning sensors to IOT device	4
4.	Integrate motion and orientation sensors to IOT device	4

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Understand the concept of IOT
2.	Study IOT architecture and applications in various fields

3.	Study the security and privacy issues in IOT.
4.	Understand various applications of sensor in Industrial, healthcare, commercial, and building automation.

Bibliography:

Sr. No.	Book Detail	Year of Publication
1.	Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", VPT, 1st Edition	2014
2.	Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications, 1st Edition	2013
3.	CunoPfister, "Getting Started with the Internet of Things", OReilly Media	2011
4.	Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing	2015

MOOCs on this course are available at:

1) Introduction to Internet of Things - https://www.edx.org/course/introduction-to-the-internet-of-things-iot
2) IoT Programming and Big Data -https://www.edx.org/course/iot-programming-big-data-curtinx-iot4x

Course Name	**:**	**Machine Learning**
Course Code	**:**	**SCM5012**
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**4-6**

Total No. Lectures: 14
Total No. of Lab hrs. 14

Course Objectives:

The main objectives of this course are:

- To gain in depth understanding the fundamental issues and challenges of machine learning: data, classifiers, reasoning behind Model selection, model complexity, etc.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Basics of machine learning:** Applications of Machine Learning, processes involved in Machine Learning, Introduction to Machine Learning Techniques: Supervised Learning, Unsupervised Learning and Reinforcement Learning, Real life examples of Machine Learning.	3
2	**Supervised learning:** Classification and Regression: K-Nearest Neighbour, Linear Regression, Logistic Regression, Support Vector Machine (SVM), Evaluation Measures: SSE, MME, R2, confusion matrix, precision, recall,F-Score, ROC-Curve.	6
3	**Unsupervised learning:** Introduction to clustering, Types of Clustering: Hierarchical-Agglomerative Clustering and Divisive clustering; Partitional Clustering - K-means clustering, Principal Component Analysis, ICA.	5

Lab Work:

Sr. No.	Lab contents	No. of Hours
1.	**Python Introduction:** Loops and Conditions and other preliminary stuff, Functions, Classes and Modules, Exceptions, Database access, Mathematical computing with Python packages like: numpy, Mat- plotLib, pandas Tensor Flow, Keras,	8
2.	Application Oriented Project Work	6

Course Outcomes:

At the completion of this course, students will be able to:	
1.	The students should be able to design and implement machine learning solutions to classification, regression and clustering problems
2.	The students should be able to evaluate and interpret the results of the different ML techniques
3.	Ability to design and implement various machine learning algorithms in a range of Real-world applications.
4.	Proficiency in using Python for various applications.

Bibliography:

Sr. No.	Book Detail	Year of Publication
1	Tom Mitchell, Machine Learning, McGraw Hill,	2017
2	Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer,	2011.
3	T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e,	2008.
4	Yuxi (Hayden) Liu, "Python Machine Learning By Example", Packt Publishing Limited	2017

MOOCs on this course are available at:

1) Data Science: Machine Learning -https://www.edx.org/course/data-science-machine-learning
2) Machine Learning - https://www.coursera.org/learn/machine-learning

Course Name	**:**	**Design of Experiments and Research Methodologies**
Course Code	**:**	**DRM5011**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Segment	**:**	**1-6**

Total No. Lectures: 28

Total No. of Lab hrs. 28

Course Objectives:

The main objectives of this course are:

- To develop an understanding of how to identify research topics, formulate research questions / hypotheses, select an appropriate research and, where applicable, experimental design.
- To provide a basis so the student can effectively develop a research proposal for either a capstone project, master's thesis, research project, or designed experiment.

Course Contents:

Module-I (Common for all branches)

Sr. No.	Course contents	No. of Lectures
1.	Introduction: Types of Research and Their Purposes, Locating, Analysing, stating and evaluating research problem, need for literature review, steps in conducting literature review, SWOT analysis, research questions and hypothesis, types of hypothesis, evaluation of hypothesis.	**4**
2.	**Statistical Methods of Analysis:** Descriptive statistics: mean, median, mode, range, mean deviation and standard deviation, regression and correlation analysis, inferential statistics: t-tests, Chi-square tests. Correlation (rank difference and product moment), ANOVA (one way)	**8**
3.	Procedure for writing a research report and manuscript: Types of research reports, steps of writing a report, layout of report, layout of research paper, ethical issues related to publishing, Plagiarism and Self-Plagiarism.	**2**

Module-II (For Circuital Branch)

4	Research Design and Sampling Design: Concept of research design, features of a good research design, concept of population and sample, characteristics of sample design, types of sampling techniques	**6**
5	**Methods of data collection and measurement:** Primary data and Secondary data, data collection techniques: observation, interview, questionnaires, schedules, case-study, levels of measurement, problems in measurement in research – validity, reliability.	**8**

Module-III (For non-Circuital Branch)

5.	Engineering Research: Planning & management of experiments; Conventional method for experiment: One factor at a time (OFAT) experiment, Concept of design of experiments: Common terms, Designed experiment, Full factorial experiments: Orthogonality of experiments, Y = F (x) for DoE, main effect analysis, interaction analysis and results	4
6.	Fractional factorial experiments, Resolution of design, screening DoE, practicing with excel and statistical software, Optimizing using Response Surface Methodology (RSM)	5
7.	Taguchi Methods: Difference between conventional DoE and Taguchi methods, Orthogonal arrays, Taguchi's Robust parameter design, Noise factors, S/N ratio, Selection of right orthogonal array	5

Lab Work:

Sr. No.	**Lab contents**	**No. of Hours**
1.	Select a problem from your area of interest, identifying the type of research problem it is and perform the SWOT analysis of the existing literature.	4
2.	Generate research questions and hypotheses for a problem from your area of interest.	4
3.	Identify the population and sample for the study (highlighting the technique used for sample selection) for a problem from your area of interest.	4
4.	Design a questionnaire for the problem of interest.	4
5.	Utilizing software such as SPSS, Mini Tab, etc. for the statistical analysis of the results obtained for the desired questionnaire.	6
6.	Preparing a research paper for the problem of interest	6

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Developed an understanding of how to identify research topics, formulate research questions and corresponding hypotheses, select an appropriate research and where applicable, experimental design.
2.	Perform required statistical analyses for any univariate application in a business / industrial setting, regardless of data form, and will be familiar with major indices for measuring correlation and association.
3.	Further, the underlying assumptions related to each statistical test and its interpretation will be thoroughly reviewed.

Bibliography:

Sr. No.	Book Detail	Year of Publication
1.	Probability and Statistics for Engineers and scientists by Anthony J. Hayter, Cencage Learning, 4th Edition	2016
2.	Probability and Statistics for Engineers and scientists by Walpole, Myers, Myers and Ye, 8th ed Pearson Education	2007
3.	Research Methodology - Methods and Techniques, C. K. Kothari, New Age International, 2nd Edition	2004
4.	English for writing research papers by Adrian Wallwork, 2nd Edition. Springer	2016
5.	Statistics: Concepts and Controversies by David S. Moore, William I. Notz, W. H. Freeman	2016

Course Name	**:**	**Electronics System Design**
Course Code	**:**	**EVM5011**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Segment	**:**	**1-6**

Total No. of Lectures: 28
Total No. of Lab Hours: 28

Course Objectives:

The main objectives of this course are:

- To introduces the student to the fundamentals of combination logic design and then to sequential circuits (both synchronous and asynchronous).
- To develop an understanding of memory systems.
- To introduce the students to the fundamental of VHDL

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	**Design Concepts and Logic Circuits (Credits -0.5)** Digital Hardware, Design Process, Design of Digital Hardware, Introduction to VHDL.	**7**
2.	**Optimized Implementation of Combinational Logic Circuits (Credits -0.5)** Strategy for minimization, Incompletely specified functions, Multiple output circuits, Multilevel synthesis & Analysis. Building Block, Multiplexers Decoders, Encoders Code Converters and their implementation in VHDL	**7**
3.	**Synchronous and Asynchronous Sequential Circuits (Credits -0.5)** Synchronous sequential circuits ,basic design steps, Mealy state model, design of FSM and their implementation using VHDL programming. Asynchronous sequential circuits analysis, synthesis, state reduction, state assignment, hazards.	**7**
4.	**Digital System Design and Testing of Logic Circuits(Credits -0.5)** Digital system design ,building block circuits, testing of logic circuits fault model, path sensitizing, random testing, circuits with tree structure.	**7**

Lab Work

Sr.No	**Lab Module (Credits -0.5)**	No. of Hours
1.	Simulation and synthesis of digital circuits with VHDL using Xilinx ISE:Test vector generation and timing analysis of sequential and combinational logic design realized using HDLs, verification of the functionality of designed circuits using function simulator.	28

Course Outcomes

At the completion of this course, students will be able to:	
1	Design, simulate, build and debug complex combinational and sequential circuits based on an abstract functional specification.
2	Implement the PLD based designs using both schematic capture and VHDL

Bibliography:

Sr.No	Book Detail	Year of Publication
1	Alan B. Marcovitz," Introduction to Logic Design", Third Edition, McGraw Hill.	2010
2	Ronald J. Tocci, Neal S. Widmer & Greg Moss, Digital Systems, Global Edition, 12/E,Pearson Education Limited.	2016
3	Bhaskar, A VHDL Primer, Third Edition, Prentice Hall.	2003
4	Research and review papers in specific area.	

Course Name	**:**	**Digital VLSI Design**
Course Code	**:**	**EVM5021**
Credits	**:**	**3**
L T P	**:**	**2-0-2**
Segment	**:**	**1-6**

Total No. of Lectures: 42

Course Objectives:

The main objectives of this course are:

- To introduce the students to the fundamental principles of VLSI circuit design
- To examine the basic building blocks of large-scale digital integrated circuits.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	**Review of MOSFET operation and CMOS process flow (Credits -0.5)**MOS Threshold voltage, MOSFET I-V characteristics: long and short channel, MOSFET capacitances, lumped and distributed RC model for interconnects, transmission lines, CMOS process flow, layout and design rules.	**7**
2.	**CMOS Inverter (Credits -0.5):**Static characteristics, power consumption, dynamic behavior, buffer design using the method of logical effort	**7**
3.	**Combinational logic (Credits -0.5):**Transistor sizing in static CMOS logic gates, static CMOS logic gate sizing considering method of logical effort, dynamic logic, pass-transistor logic, common mode and other cross-coupled logic families	**7**
4.	**Sequential logic (Credits -0.5):**Static latches and flip-flops (FFs), dynamic latches and FFs, sense-amplifier based FFs, NORA-CMOS, Schmitt trigger, monostable and astable circuits.	**7**
5.	**Memories and array structures (Credits -0.5):**MOS-ROM, SRAM cell, memory peripheral circuits, signal to noise ratio, power dissipation,	**7**
6.	**Timing (Credits -0.5) :**Timing fundamentals, clock distribution, jitter, self-timed circuit design, synchronizers and arbiters, basic building blocks of PLLs, clock synthesis and synchronization using PLLs.	**7**

Course Outcomes:

At the completion of this course, student will be able to:	
1	Design logic circuit layouts for both static CMOS and dynamic clocked CMOS circuits
2	Extract the analog parasitic elements from the layout and analyze the circuit timing using a logic simulator and an analog simulator
3	Perform testing of hardware into the VLSI chip and analyze VLSI circuit timing using logical effort analysis and to estimate and compute the power consumption of a VLSI chip.

Bibliography:

Sr.No	Book Detail	Year of Publication
1	Kang, S. and Leblebici, Y., CMOS Digital Integrated Circuits – Analysis and Design, Tata McGraw Hill 3rd ed.	2008
2	Weste, N.H.E. and Eshraghian, K., CMOS VLSI Design: A Circuits and Systems Perspective, Addision Wesley 2nd ed	1998
3	Rabaey, J.M., Chandrakasen, A.P. and Nikolic, B., Digital Integrated Circuits – A Design Perspective, Pearson Education 2nd ed.	2007
4	aker, R.J., Lee, H. W. and Boyce, D. E., CMOS Circuit Design, Layout and Simulation, Wiley – IEEE Press 2nd ed.	2004
5	Weste, N.H.E., Harris, D. and Banerjee, A., CMOS VLSI Design, Dorling Kindersley 3rd ed.	2006
6	Research and review papers in specific area	

Course Name	:	**Low Power Techniques**
Course Code	**:**	**EVM5101**
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**1-3**

Total No. of Lectures: 14
Total No. of Lab Hours: 14

Course Objectives:

The main objectives of this course are:

- To introduce the students to the state-of-the-art techniques for optimization of systems. Power is the vital design constraint in almost all electronic devices, battery operated applications. For low power design of digital systems
- To introduce the students to the the methods and tools for power optimization used at all stages of the design development flow (i.e., from system specification to implementation).
- To introduce the students to the usage of the some of the industry standard tools for low power design through Lab sessions.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	**Need for Low Power VLSI Chips (Credits -0.5)** Introduction, sources of power dissipation in digital Integrated circuits. Emerging low power approaches, estimation of power dissipation due to switching, short circuit, sub-threshold leakage, and diode leakage currents. Device & technology impact on low power, dynamic dissipation in CMOS. Impact of technology, scaling , transistor sizing and gate oxide thickness on power dissipation.	**7**
2.	**Power Analysis and Optimizations (Credits -0.5)** Threshold voltage scaling and control, multiple threshold CMOS (MTCMOS), Substrate bias controlled variable threshold CMOS, testing issues: Design and test of low-voltage CMOS circuits. Circuit and logic style, adiabatic logic circuits. Power analysis and optimization, Power analysis techniques, energy recovery techniques, software power estimation and optimization of low-power memory circuits and architectures	**7**

Lab Work

Sr.No	**Lab Module (Credits -0.5)**	No. of Hours
1.	Introduction to CADENCE (Operating Point Analysis, DC Sweep, Transient Analysis, AC Sweep, Parametric Sweep, Transfer Function Analysis). Design the circuits and verify the following: i) DC Analysis ii) AC Analysis iii) Transient Analysis.	14
2.	To identify the problem statement, analyze and compare the various parameters.	

Course Outcomes

At the completion of this course, students will be able to:	
1	Use mathematical methods and circuit analysis models in analysis of CMOS digital electronics circuits, including logic components and their interconnect.
2	Create models of moderately sized CMOS circuits that realize specified digital functions
3	Apply CMOS technology-specific layout rules in the placement and routing of transistors and interconnect, and to verify the functionality, timing, power, and parasitic effects.

Bibliography:

Sr.No	Book Detail	Year of Publication
1	Roy, K. and Prasad, Sharat C.," Low Power CMOS VLSI: Circuit Design", John Wiley.	2000
2	Rabaey, J.M. and Pedram, M.," Low Power Design Methodologies", Springer.	1996
3	Chandrakasan, A.P. and Broderson, R.W., "Low Power Digital CMOS Design", Kluwer.	1995
4	Bellaouar, A. and Elmasry, M.I.," Low-Power Digital VLSI Design : Circuits and Systems", Kluwer.	1995
5	Research and review papers in specific area	

Course Name	**:**	**Microwave Integrated Circuits**
Course Code	**:**	**EVM5102**
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**1-3**

Total No. Lectures: 14
Total No. of Lab Hours: 14

Course Objectives:

The main objectives of this course are:

- To provide an in-depth treatment of the theory of different types of planar transmission line structures and their applications for the development of integrated circuits at microwave and milli-meter wave frequencies.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Module-1** Planar Transmission Lines and Lumped Elements for MICs: **(Credit- 0.5)** Fundamentals of transmission lines, Foundations of Microstrip lines, Striplines, Slotlines, Coplanar waveguides, Coplanar strips; Launching Techniques: Coaxial line to microstrip transition, Rectangular waveguide to microstrip transition, microstrip to slot-line transition, microstrip to coplanar waveguide (CPW) transition, Lumped Components: Capacitors, Inductors and Resistors.	7
2.	**Module -2** Active and Passive Circuits **(Credit- 0.5)** Introduction, open-circuit end correction, corners, symmetrical step, T-junction, series gaps, Bends, Design of power dividers and combiners, directional couplers, hybrid couplers, phase shifter, filters	7

Lab Work:

Sr. No.	Lab contents MIC Design & Simulations Lab **(Credit- 0.5)**	No. of Hours
1.	Modelling & Simulation of planar transmission lines and circuits.	14

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Attain in-depth knowledge of different types of planar transmission line structures for ICs at microwave and millimeter wave frequencies.
2.	Design and simulation of planar transmission lines and circuits.

Bibliography:

Sr. No.	Book Detail	Year of Publication
1	Fooks, E.H. and Zakarevicius, R.A., "Microwave Engineering Using Microstrip Circuits," Prentice-Hall	1990
2	Franco di Paolo, "Networks and Devices using Planar Transmission Lines," CRC Press	2000
3	Pozar, D.M., "Microwave Engineering", 3rd Ed., John Wiley & Sons	2004
4	Roberto Sorrentino and Giovanni Bianchi, "Mirowave and RF	2010

	Engineering" John Wiley & Sons	
5	Koul, S.K., "Millimeter Wave and Optical Dielectric Integrated Guides and Circuits", John Wiley & Sons	1997
6	Research and Review papers in specific area	

Course Name	**:**	**RF and Microwave MEMS-I**
Course Code	**:**	**EVM5103**
Credits	**:**	**1.5**
L T P	**:**	**3 0 0**
Segment	**:**	**1-3**

Total No. Lectures: 21

Course Objectives:

The main objectives of this course are:

- To provide an in-depth knowledge of Microelectromechanical Systems (MEMS) and their applications in RF and wireless engineering.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Module-1** RF MEMS **(Credit- 1.0)** RF MEMS for microwave applications, MEMS technology and fabrication, mechanical modeling of MEMS devices, MEMS materials and fabrication techniques.	No of hrs 14
2.	**Module -2** MEMS Switches **(Credit- 0.5)** Introduction to MEMS switches; Capacitive shunt and series switches: Physical description, circuit model and electromagnetic modeling; Techniques of MEMS switch fabrication and packaging; Design of MEMS switches.	7

Course Outcomes:

At the completion of this course, students will be able to:	
1	Attain in-depth knowledge of basics of MEMS technology
2.	Understand the potential applications of MEMS in RF and wireless engineering.

Bibliography:

Sr. No.	Book Detail	Year of Publication
1	Varadan, V.K., Vinoy, K.J. and Jose, K.J., "RF MEMS and their Applications", John Wiley & Sons	2002
2	Rebeiz, G.M., "MEMS: Theory Design and Technology", John Wiley & Sons	1999
3	De Los Santos, H.J, "RF MEMS Circuit Design for Wireless Communications", Artech House	1999
4	Trimmer, W., "Micromechanics & MEMS", IEEE Press	1996
5	Madou, M., "Fundamentals of Microfabrication", CRC Press	1997
6	Sze, S.M., "Semiconductor Sensors", John Wiley & Sons	1994
7	Research and Review papers in specific area	

Course Name	**:**	**FPGA and ASIC**
Course Code	**:**	**EVM5104**
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**1-3**

Total No. Lectures: 14
Total No. of Lab hrs. 14

Course Objectives:

The main objectives of this course are:

- To understand automated design flows supporting designs with FPGAs.
- To understand fundamental concepts of FPGA.
- To understand different technologies to configure FPGA and various FPGA architectures.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Introduction to FPGA and ASIC (Credit- 0.5)** VLSI Design Flow, Design Hierarchy, VLSI Design Styles, Types of ASIC, Full custom ASIC, Gate Array Based ASIC, Standard Cell Based ASIC, FPGA versus ASIC, Fuse, Antifuse, PROM, EPROM, EEPROM, Flash and SRAM based FPGAs, Circuit Design of FPGA fabrics. Fine, medium and coarse grained architectures , MUX versus LUT-based logic blocks, CLBs versus LABs versus slices, Fast carry chain.	7
2.	**HDL (Credit- 0.5)** Basic concepts of hardware description languages, An overview of VHDL and verilog HDL, Structural, Data-flow and Behavioural styles, Delay modelling, Control statements, FSM modelling of hardware description language, Datatypes, Operators and Attributes, Concurrent and Sequential Code, Signal and Variable, Package and Components, Function and Procedure	7

Lab Work:

Sr. No.	Lab contents Simulation and Implementation Credit- 0.5)	No. of Hours
1	Simulation and Implementation of Various Flipflops, Generic address decoder with and without generate ,Tristate buffer, Legal and illegal assignments, Multiplexer implemented with operators and using when and select, Implementing sequential circuits with concurrent code and concurrent circuits using sequential code, counter shift register, carry ripple adder, leading zeros, slow 0 to 9 counter with SSD, Generic hamming weight with concurrent code, Circular shift register with component, Parity detector with component and generic map using Xilinx ISE	14

Course Outcomes:

At the completion of this course, the students will be able to:	
1.	Design and manually optimize complex combinational and sequential circuits.
2.	Understand the design model, method, criterion and steps of FPGA design.

3.	Understanding the configuration of FPGA.
4.	Learning the performance specification of FPGA devices.

Bibliography:

Sr. No.	Book Detail	Year of Publication
1	Wayne Wolf, FPGA - Based System Design, Pearson education, LPE 1st Indian Reprint	2004
2	Michad John, Sebastian Smith, Application Specific Integrated Circuit, Pearson Education	2006
3	John V.Oldfield, Richard C. Dorf, Field Programmable Gate Arrays, John Wiley & Son	1995
4	Maxfield, Clive. The design warrior's guide to FPGAs: devices, tools and flows. Elsevier	2004
5	Pedroni, A., Volnei Circuit design and simulation with VHDL, MIT Press, second edn	2010
6	Research and Review papers in specific area	

Course Name	:	**Semiconductor Memories**
Course Code	**:**	**EVM5105**
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**1-3**

Total No. of Lectures: 14
Total No. of Lab Hours: 14

Course Objectives:

The main objectives of this course are:

- To learn about SRAM – SRAM Cell structures, MOS SRAM Architecture, MOS SRAM cell and peripheral circuit operation, Bipolar SRAM technologies, SOI technology, Advanced SRAM architectures and technologies.
- To learn about different memory devices like RAM, ROM, PROM, EPROM, EEPROM, etc.
- To get acquainted with different terms like read, write, access time, nibble, byte, bus, word length, address, volatile, non-volatile, etc. How to implement combinational and sequential circuit using ROM.

Course Contents:

Sr. No	Course Contents	No. of Lectures
1.	**Static random access memory(SRAM) technologies (Credits-0.5)**Static random access memories (SRAMs): SRAM cell structure, MOS SRAM, Architecture-MOS SRAM cell and peripheral circuit operation, bipolar SRAM technologies-silicon on insulator (SOI) technology, advanced SRAM architectures and application specific SRAMs.	**7**
2.	**DRAM Technologies and Non-volatile Memories (Credits-0.5)** Dynamic random access memories (DRAMs): DRAM technology development CMOS , DRAM-DRAM cell theory and advanced cell strucutures, BiCMOS, DRAMs-soft error failures in DRAMs-Advanced DRAM designs and architecture-application, Specific DRAMs. Masked read-only memories (ROMs)-High density ROMs-programmable read-only memories (PROMs)-bipolar PROMs-CMOS PROMs-Erasable (UV) – Programmable road-only memories (EPROMs)-floating-gate EPROM cell-one-time programmable (OTP) EPROMs-Electrically Erasable PROMs (EEPROMs)-EEPROM technology and architecture, nonvolatile SRAM-flash memories (EPROMs or EEPROM), advanced flash memory architecture.	**7**

Lab Work

Sr.No	**Device Modelling and Simulation (Credits- 0.5)**	No. of Hours
1.	Introduction to CADENCE (Operating Point Analysis, Transient Analysis, Parametric Sweep). Design SRAM cell and calculate it's delay	14

	parameter. Comparison of SRAM cell using 180nm and 90nm technology.	
2.	To identify the problem statement, analyze and compare the various SRAM cell.	

Course Outcomes

At the successful completion of this course, student will be able to:	
1	Describe the technology used in the construction of digital memory and assess the quality of various memory types.
2	Draw the schematic of a static and dynamic memory cell and explain in details the process of reading and writing a bit of information in it.
3	Learn about SRAM – SRAM Cell structures, MOS SRAM architecture, MOS SRAM cell and peripheral circuit operation, Bipolar SRAM technologies, SOI technology, advanced SRAM architectures and technologies.

Bibliography:

Sr.No	Book Detail	Year of Publication
1	Ashok K.Sharma," Semiconductor Memories Technology, Testing and Reliability", Prentice-Hall of India Private Limited, New Delhi.	2007
2	Tegze P .Haraszti, "CMOS Memory Circuits", Kluwer Academic Publishers.	2003
3	Betty Prince, "Emerging Memories: Technologies and Trends", Kluwer Academic publishers.	2002
4	Research and review papers in specific area.	

Course Name	:	**Low Power Subsystem Design**
Course Code	**:**	**EVM5201**
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**4-6**

Total No. of Lectures: 14
Total No. of Lab Hours: 14

Course Objectives:

The main objectives of this course are:

- To introduce the students to an exhaustive review of methods for power estimation of digital VLSI subsystems.
- To understand both dynamic and static (i.e., leakage) power.
- To understand the problems of modeling, estimation of power consumption addressed at different levels of abstraction.
- To introduce the students to the usage of industry standard tool for low-power design through Lab sessions.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	**Low power Architecture & Systems Power (Credits – 0.5)** Low power Architecture, systems power and performance management, switching activity reduction, parallel architecture with voltage reduction, low power arithmetic components, low power low voltage adder design approaches, multiplier design approaches and low power memory design, Low-Power Memory Circuits and architectures.	**7**
2.	**Low Power Clock Distribution And Special Techniques (Credits – 0.5)**Power dissipation in clock distribution, single driver vs distributed buffers, zero skew vs tolerable skew, chip and package co design of clock network. Power reduction in clock networks, CMOS floating node, low power bus delay balancing, and low power techniques for SRAM. Power conscious high level synthesis, silicon on insulator based technologies.	**7**

Lab Work

Sr.No	**List of Experiments (Credits – 0.5)**	No. of Hours
1.	Introduction to CADENCE (Operating Point Analysis, DC Sweep, Transient Analysis, AC Sweep, Parametric Sweep, Transfer Function Analysis) Design adder and subtractorcircuit usinguniversal gates and verify its output. Design a full adder using half adder.Design a latch specifying some time constraints using universal gates. Design decoder using MOS technology.	14
2.	To identify the problem statement, analyze and compare the various parameters.	

Course Outcomes

At the completion of this course, student will be able to:	
1	Design chips used for battery-operated systems and high-performance circuits not exceeding power limits.
2	Understand the concepts of low voltage, low power logic circuits.
3	Recognize advanced issues in VLSI systems, specific to the deep-submicron silicon technologies.

Bibliography:

Sr.No	Book Detail	Year of Publication
1	Kiat-Seng Yeo, Roy K., Low voltage Low power VLSI subsystems, Tata Mcgraw-Hill.	2004
2	Roy, K. and Prasad, Sharat C., Low Power CMOS VLSI: Circuit Design, John Wiley.	2000
3	Rabaey,J,M. and Pedram, M., Low power design methodologies,Springer	1996
4	Chandrakasan, A.P. and Broderson, R.W., Low Power Digital CMOS Design, Kluwer.	1995
5	Bellaouar, A. and Elmasry, M.I., Low-Power Digital VLSI Design : Circuits and Systems, Kluwer.	1995
6	Research and review papers in specific area.	

Course Name	**:**	**Semiconductor Microwave Devices**
Course Code	**:**	**EVM5202**
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**4-6**

Total No. Lectures: 14
Total No. of Lab hrs. 14

Course Objectives:

The main objectives of this course are:

- To introduce to the students, the principles of operation of various microwave and millimetre wave semiconductor devices and their applications.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Module-1** High Frequency Materials **(Credit- 0.5)** Band structure, Direct and indirect semiconductors, abrupt isotype/anisotype junctions, electrical and optoelectronic properties, 2-Dimensional Electron Gas (2-DEG), novel materials	7
2.	**Module -2*** High Frequency Devices **(Credit- 0.5)** PIN Diode, Schottky diodes, Tunnel diode, Gunn Diode, IMPATT Diode, Novel Devices	7
3.	**Module -3*** Heterostructure Devices **(Credit- 0.5)** Heterojunction bipolar transistor (HBT), MOSFETs, high electron mobility transistor (HEMT), LED and Photodetectors	7

*** Students can opt any one module (module 2 or module 3)**

Lab Work:

Sr. No.	Lab contents **D**evice Modelling and Simulation Lab **(Credit- 0.5)**	No. of Hours
1	Modelling and simulation of microwave devices using Software (such as SILVACO TCAD).	14

Course Outcomes:

At the completion of this course, student will be able to:	
1.	An in-depth knowledge of different semiconductor materials.
2.	Understand operation/working principle of different semiconductor devices for microwave applications
3.	Design and simulate of microwave devices

Bibliography :

Sr. No.	Book Detail	Year of Publication
1	Sze, S. M., and Ng, K. K., "Physics of Semiconductor Devices", 3rd Ed., Wiley-Interscience.	2006.
2	Tsividis, Y., "Operation and Modeling of the MOS Transistor", 2nd Ed., Oxford University Press,	2003.
3	Arora, N., "MOSFET Models for VLSI Circuit Simulation: Theory and Practice", 4th Ed., Springer-Verlag,	1993.

4	Sarrafzadeh, M. and Wong, C.K., “An Introduction to VLSI Physical Design”, 4th Ed., McGraw-Hill,	1996.
5	Wolf, W., “Modern VLSI Design System on Silicon”, 2nd Ed., pearson Education,	2000.
6	Research and Review papers in specific area.	

Course Name	**:**	**RF and Microwave MEMS-II**
Course Code	**:**	**EVM5203**
Credits	**:**	**1.5**
L T P	**:**	**3 0 0**
Segment	**:**	**4-6**

Total No. Lectures: 21

Course Objectives:

The main objectives of this course are:

- To understand Microelectromechanical Systems (MEMS) and their applications in RF and wireless engineering.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Module-1** MEMS Inductors and Capacitors (Credit- 0.5) MEMS switches; Capacitive shunt and series switches; Micromachined inductors: Effect of inductor layout, reduction of stray capacitance of planar inductors, folded inductors, variable inductors and polymer-based inductors; MEMS Capacitors: Gap-tuning and area-tuning capacitors, dielectric tunable capacitors.	7
2.	**Module -2** MEMS Filters and Phase Shifters (Credit- 0.5) Modeling of mechanical filters, micromachined filters, surface acoustic wave filters, micromachined filters for millimeter wave frequencies; Various types of MEMS phase shifters; Ferroelectric phase shifters.	7
3.	**Module -3** Integration and Packaging **(Credit- 0.5)** Role of MEMS packages, types of MEMS packages, module packaging, packaging materials and reliability issues.	7

Course Outcomes:

At the completion of this course, students will be able to:	
1	Attain in-depth knowledge of basics of MEMS technology
2.	Understand the potential applications of MEMS in RF and wireless engineering.

Bibliography:

Sr. No.	Book Detail	Year of Publication
1	Varadan, V.K., Vinoy, K.J. and Jose, K.J., "RF MEMS and their Applications", John Wiley & Sons	2002
2	Rebeiz, G.M., "MEMS: Theory Design and Technology", John Wiley & Sons	1999
3	De Los Santos, H.J, "RF MEMS Circuit Design for Wireless Communications", Artech House	1999
4	Trimmer, W., "Micromechanics & MEMS", IEEE Press	1996
5	Madou, M., "Fundamentals of Microfabrication", CRC Press	1997
6	Sze, S.M., "Semiconductor Sensors", John Wiley & Sons	1994
7	Research and Review papers in specific area	

Course Name	**:**	**FPGA Based System Design**
Course Code	**:**	**EVM5204**
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**4-6**

Total No. Lectures: 14
Total No. of Lab hrs. 14

Course Objectives:

The main objectives of this course are:

- To understand Components embedded on FPGA
- To understand fundamentals of the FPGA design tools.
- To understand reconfigurable computing systems and the roles of FPGAs in those systems.
- To explore the development and deployment of FPGA based digital systems.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Embedded blocks in FPGA and Logic Synthesis (Credit-0.5)** Embedded RAMs, Embedded multipliers, adders, MACs, Embedded processor cores(hard and soft), Clock trees and clock managers, General-purpose I/O, Gigabit transceivers, Hard IP, Soft IP and Firm IP, System gates versus real gates., Simulation with VHDL testbenches, Physical design compilation, simulation and implementation. Floor planning and placement, routing and its types, commercial EDA tools for synthesis, advanced FPGA applications, future of FPGAs.	7
2.	**System Level FPGA Design (Credit- 0.5)** State Machines, Basic Displays, Memory Circuits, Serial Communication Circuits, VGA and DVI Video Interfaces, FPD-link Video Interfaces.	7

Lab Work:

Sr. No.	Lab contents **Simulation and Implementation (Credit- 0.5)**	No. of Hours
1	Simulation and implementation of finite state machine using Xilinx, vending machine controller, zero to nine counter, car alarm with bypasses prevented by a flag, FSM with embedded timer, traffic light controller, pushbutton sequence detector, seven segment display, frequency meter, digital clock, quick finger game, RAM and ROM design with various architectures, serializer and deserializer circuit, PS2 interface, I^2C interface, SPI interface, TMDS interface, VHDL design of VGA video, DVA video and FPD-link video interface using Xilinx ISE.	14

Course Outcomes:

At the successful completion of this course, student will be able to:	
1.	Design and model digital circuits with HDL at behavioral, structural, and RTL Levels.
2.	Develop and test benches to simulate combinational and sequential circuits.
3.	Design of various video interfaces using HDL.

Bibliography:

Sr. No.	Book Detail	Year of Publication
1	Pedroni, A., Volnei Circuit design and simulation with VHDL, MIT Press, second edn.	2010
2	J. Bhaskar, VHDL Primer, Pearson Education Asia	2001
3	Palnitkar, Samir, Verilog HDL: a guide to digital design and synthesis, Prentice Hall Professional	2003
4	Michad John, Sebastian Smith, Application Specific Integrated Circuit, Pearson Education	2006
5	Maxfield, Clive. The design warrior's guide to FPGAs: devices, tools and flows. Elsevier	2004
6	Research and Review papers in specific area.	

Course Name	:	**Memory Design and Testing**
Course Code	**:**	**EVM5205**
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**4-6**

Total No. of Lectures: 14
Total No. of Lab Hours: 14

Course Objectives:

The main objectives of this course are:

- To learn RAM fault modeling and testing for memory.
- To learn about Ferroelectric RAMs (FRAMs), analog memories, magneto resistive RAMs (MRAMs), MCM(3D and 2D) ,hybrid memory, MCM testing and reliability issues, memory cards, high density memory packaging future directions.

Course Contents:

Sr. No	Course Contents	No. of Lectures
1.	**Reliability and Memory Fault Modelling** (**Credit-0.5)** General reliability issues-RAM failure modes and mechanism, non-volatile memory reliability, reliability modelling and failure rate prediction, design for reliability-qualification. RAM fault modelling, electrical testing, pseudo random testing-megabit DRAM testing, non-volatile memory modelling and testing-IDDQ fault modelling and testing-application specific memory testing, memory-subsystem technologies, high-performance standard DRAMS, embedded memories.	**7**
2.	**Advanced Memory Technologies and High-Density Memory Packing Technologies (Credit- 0.5)** low-power memory circuits: sources and reduction of power dissipation in a ram subsystem and chip, low-power dram circuits, low power SRAM circuits. Ferroelectric RAMs (FRAMs), GaAs FRAMs, Analog memories, magneto resistive RAMs (MRAMs), Experimental memory devices, Memory Hybrids and MCMs (2D), Memory stacks and MCMs (3D), Memory MCM testing and reliability issues, memory cards, high density memory packaging future directions.	**7**

Lab Work

Sr. No	**List of Experiments (Credits – 0.5)**	No. of Hours
1.	Introduction to CADENCE (Operating Point Analysis, DC Sweep, Transient Analysis, AC Sweep, Parametric Sweep, Transfer Function Analysis. Design memory with write and read operation.	14
2.	To identify the problem statement, analyze the various memory related issues.	

Course Outcomes

At the completion of this course, students will be able to:	
1	Draw the schematic of a typical sense amplifier and explain how it works.
2	Draw a schematic of a simple (2-3 bit) NOR/NAND NMOS address decoder and explain how it decodes a given address.
3	Learn RAM fault modelling, Electrical testing, Pseudo Random testing, Megabit DRAM Testing, non-volatile memory modelling and testing.
4	Learn IDDQ fault modelling and testing, Application specific memory testing, RAM fault modelling, BIST techniques for memory
5	Learn about Ferroelectric RAMs (FRAMs), GaAs FRAMs, Analog memories, magneto resistive RAMs (MRAMs), Experimental memory devices, Memory Hybrids and MCMs (2D), Memory Stacks and MCMs (3D)

Bibliography:

Sr. No	Book Detail	Year of Publication
1	Ashok K. Sharma,"Semiconductor MemoriesTechnology, Testing and Reliability", Prentice-Hall of India Private Limited, New Delhi.	2007
2	Tegze P. Haraszti, "CMOS Memory Circuits", Kluwer Academic Publishers.	2003
3	Adams R. D., High performance Memory Testing: Design Principles, Fault Modeling and Self-Test, Springer.	2002
4	Itoh, K., VLSI Memory Chip Design, Springer.	2006
5	Brent Keeth, R. Jacob Baker, Brian Johnson, Feng Lin "DRAM Circuit Design: Fundamental and High-Speed Topics", 2nd Edition.	2007
6	Betty Prince, "Emerging Memories: Technologies and Trends", Kluwer Academic publishers.	2005
7	Research and review papers in specific area.	

Course Name	**:**	**Fourier Transforms**
Course Code	**:**	**EMM5011**
Credits	**:**	**01**
L T P	**:**	**2-1-0**
Segment	**:**	**1-2**

Total No. of Lectures– 10,
Total No. of Tutorials -5

Course Objectives:

The main objectives of this course are:

- To make the students understand the concept of Fourier transform and be able to compute it for standard examples.
- To make the students able to apply Fourier transforms to solve differential equations and partial differential equations.

Course contents:

Sr.No	Course Contents	No. of Lectures
1	**Fourier Transforms:** Fourier Integral formulas, Definition and examples, Basic properties, Fourier cosine and sine transforms and examples, Basic properties of Fourier cosine and sine transforms, Multiple Fourier transforms.	05
2	**Fast Fourier Transforms and Short Term Fourier Transforms:** Definition and examples, Basic properties, Applications.	05

Course Outcomes:

At the end of the course, students will be able to:	
1	Solve differential equations by using Fourier transforms
2	Solve partial differential equations by using Fourier transforms
3	Apply FFT and STFT to engineering problems

Bibliography:

Sr.No.	Name of Book / Authors / Publishers	Year of Publication/ Edition
1	"Integral Transforms and Their Applications", LoknathDebnath, CRC Press, Inc.,	1995.
2	"Integral Transforms and their Applications", Brian Davies, 3rd Edition, Springer-Verlag, New York,Inc,	2001
3	"Fourier Transform and Its Applications", Ronald N. Bracewell, 2nd Edition, McGraw-Hill Inc.,US,	1986

Course Name	**:**	**Numerical Methods**
Course Code	**:**	**EMM5013**
Credits	**:**	**01**
L T P	**:**	**2-0-2**
Segment	**:**	**3-4**

Total No. of Lectures – 10
Total No. of Lab Hrs -10

Course Objectives:

The main objectives of this course are:

- To understand the basics of numerical methods.
- To solve problems on system of linear equations and Interpolation by numerical methods.

Course contents:

Sr.No	Course Contents	No. of Lectures
1	**Error Analysis:**Definition and sources of errors, Propagation of errors, Floating-point arithmetic and rounding errors.	02
2	**Interpolation:** Interpolation using Finite differences, Numerical Differentiation and Numerical integration, Trapezoidal and Simpson's rules.	04
3	**Numerical Solution of Differential Equations:** Picard's method, Taylor series method, Euler and modified Euler methods, Runge-Kutta methods, Predictor-Corrector method.	04

Lab Work:

Sr.No	Lab. Contents	No. of Hours
1.	Solving Interpolation, Numerical Differentiation and Numerical integration problems using Mathematica.	04
2.	Solving Differential equations numerically using Mathematica.	06

Course Outcomes:

At the completion of this course, students will be able to:

1. Solve problems on Interpolation
2. Solve problems on Differentiation, Integration.
3. Solve differential equations.

Bibliography:

Sr.No.	Name of Book / Authors / Publishers	**Year of Publication/ Edition**
1	"Introduction to Numerical Analysis",Atkinson K. E., John Wiley.	1989
2	"Applied Numerical Analysis", Gerald C. F. and Wheatley P. O., Pearson	2004
3	"Numerical Methods for Scientific and Engineering Computation", Jain M. K., Iyengar S.R.K. and Jain R. K., New Age International Publisher.	2004
4	"Elements of Numerical Analysis", Gupta R.S., Macmillan India Ltd .	2008

Course Name	**:**	**Optimization Techniques and Genetic Algorithms**
Course Code	**:**	**EMM5012**
Credits	**:**	**01**
L T P	**:**	**2-0-2**
Segment	**:**	**5-6**

Total No. of Lectures – 10
Total No. of Lab Hrs -10

Course Objectives:

The main objectives of this course are:

- To make the students understand the need of Optimization Techniques and develop the ability to form mathematical model of optimization problems.
- To make the students able to identify and solve linear and non-linear models of optimization problems using Genetic Algorirhms.

Course contents:

Sr.No	Course Contents	No. of Lectures
1	Introduction to optimization problem, local and global optimum, conversion of a constrained problem to unconstrained problem.	04
2	Genetic Algorithms, Binary and Real coded Genetic Algorithms, Coding and decoding of variables, Key steps in a GA, starting population, fitness evaluation, reproduction, crossover, mutation, evaluation.	06

Lab Work:

Sr.No	Lab. Contents	No. of Hours
1.	Using Genetic Algorithms in various optimization Problems	10

Course Outcomes:

At the completion of this course, students will be able to:	
1	Form mathematical model of optimization problems.
2	Distinguish between linear and nonlinear models.
3	Solve simple problems using Mathematica/MATLAB

Bibliography:

Sr.No.	Name of Book / Authors / Publishers	Year of Publication/ Edition
1	"Practical Genetic Algorithms", Haupt, R. L. and Haupt, S.E., John Wiley & Sons	1998
2	"Genetic Algorithm in Search, Optimization and Machine Learning", Goldberg, D.E., Addison Wesley.	1989
3	"Engineering Optimization", Ranjan, Ganguli, University Press.	2011

Course Name	**:**	**Communication Skills**
Course Code	**:**	**SSM5021**
Credits	**:**	**1.5**
L T P	**:**	**1-0-4**
Segment	**:**	**1-3**

Total No. Tutorials-7
Total No. of Lab hours – 28

Course Objectives:

	The main objectives of this course are:
1.	To enhance competence in communication skills: verbal and nonverbal.
2.	To provide orientation in technical communication skills: spoken and written.
3.	To sensitize students to attitude formation and behavioural skills.

Course Contents:

Sr.No	Course contents	No. of Tutorials
1.	**Introduction to Communication Skills, Soft Skills and Interpersonal Communication**	**1**
2.	**Speech:** Structure, Elements, Content, Organization and Delivery, J-a-M	**1**
3.	**Writing Skills:** Letters, Minutes of Meeting	**1**
4.	**Technical Report Writing:** Concept and Structure	**1**
5.	**Research Writing:** Concept and Structural Framework	**1**
6.	**Power Point Presentation:** Project Presentation	**1**
7.	**Interviews**	**1**

Lab Work:

Sr.No	Lab contents	No. of Hours
1.	Self- Introduction	**2**
2.	Negotiation Skills & Role Play	**2**
3.	J-a-M Session	**2**
4.	Building Word Power through Reading	**2**
5.	Group Discussion and Case Study	**4**
6.	Writing Skills: Letters, Minutes of Meeting	**2**
7.	Technical Report Writing: Concept & Structure	**4**
8.	Research Writing: Concept and Structural Framework	**4**
9.	Power Point Presentation: Project Presentation	**4**
10.	Interviews	**2**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Show enhanced competence in communication skills and technical communication.
2.	Develop awareness of attitude formation and behavioural appropriateness
3.	Gain self-confidence and perform better in their academic and professional life.

Bibliography:

Sr.No	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1.	"Technical Communication", Raman Meenakshi and Sharma Sangeeta, Oxford University Press.	**2015**

2.	"English for Research Paper Writing", Wallwork Adrian, Springer, London.	**2011**
3.	"English Vocabulary In Use: Advanced+ CD", Michael McCarthy, CUP, Cambridge.	**2004**
4.	"Advanced English Grammar", Hewings Martin, CUP, Cambridge.	**2003**
5.	"Study Listening", Tony Lynch, CUP, Cambridge.	**2004**
6.	"Study Speaking", Kenneth Anderson, CUP, Cambridge.	**2010**
7.	"Study Reading", Glendenning H. Eric, CUP, Cambridge.	**2004**
8.	"Study Writing", Hamp Lyons Liz & Heasley Ben, CUP, Cambridge.	**2004**
9.	"Study Skills in English", Wallace Michael J., CUP, Cambridge.	**2004**

MOOCs on this course are available at:

1) "Take Your English Communication Skills to the Next Level". Available at Coursera (Offered by Georgia Institute of Technology), 4 weeks, Starts on September 10, 2018.
https://www.coursera.org/learn/english-communication-capstone

2) "Effective Communication in Globalised Workplace- The Capstone". Available at Coursera (Offered by National University of Singapore), 3 weeks, Starts on August 06, 2018.
https://www.coursera.org/specializations/effective-communication

Course Name	**:**	**Management Entrepreneurship and IPR**
Course Code	**:**	**SSM5022**
Credits	**:**	**1**
L T P	**:**	**0-2-0**
Segment	**:**	**4-5**

Total No. Tutorials – 14

Course Objectives:

The main objectives of this course are:	
1.	To make students familiar with the concepts of Management, Entrepreneurship and Intellectual Property Rights (IPRs).
2.	To make students understand how to initiate a new Start-up and manage it effectively.
3.	To enable students to convert their innovative ideas into different forms of IPRs.

Course Contents:

Sr.No	Course contents	No. of Tutorials
1.	**Introduction to Management:** Concepts and Principles of Management	**1**
2.	**Functions of Management:** Planning Process - Hypothetical Planning of an Event/Activity, Form of Organization Structure - Case Study, Human Resource Planning and Process, Elements of Directing and Effective Control Mechanism, Activity: Role Playing/Management Game	**4**
3.	**Introduction to Entrepreneurship:** Concepts of Entrepreneurship and Characteristics of Entrepreneurs	**1**
4.	**Development Phases of Entrepreneurship:** Innovation and Idea Generation, Project Formulation and Validation (Feasibility Analysis), Business plan	**2**
5.	**Ecosystem for Entrepreneurship Development:** Government Schemes and Initiatives, Financial and Non-Financial Institutional Support, Legal Framework, Role of Incubator, Venture Capitalist, Angel Investor, Crowd Funding Accelerator etc.	**2**
6.	**Intellectual Property Rights (IPRs):** Concept and Relevance of IPRs, Process for filing IPR	**2**
7.	**Different Forms of IPRs:** Patents, Copyright, Trademarks, Industrial Designs and Geographic Indicator	**2**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Develop and manage new project/Start-up.
2.	Apply managerial skills for success of entrepreneurial/business venture.
3.	Make effective use of IPR practices in their ventures.

Bibliography:

Sr.No	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1.	"Management Principles and Practice", Srinivasan R. and Chunawalla S.A., Himalaya Publishing House.	**2017**
2.	"Introduction to Management", Schermerhorn John R. Jr. And Bachrach Daniel G., 13th Edition, Wiley Publications	**2016**
3.	"Principles & Practice of Management", Prasad L.M., 8th Edition, Sultan Chand & Sons.	**2015**
4.	"The New Era of Management", Daft R.L., 11th Edition, Pubs: Cengage Learning.	**2014**

5.	"Case Studies in Management", Pandey Chandra Akhilesh, 2nd Edition, I.K. International Publishing House Pvt. Ltd.	**2015**
6.	"Harvard Business Review: Manager's Handbook", Harvard Business School Press.	**2018**
7.	"Entrepreneurship", Trehan Alpana, Dreamtech Press.	**2016**
8.	"Entrepreneurship and Small Business" Schaper Michael, Volery Thierry, Weber Paull and Lewis Kate, 3rd Asia-Pacific Edition, Wiley Publications	**2018**
9.	"Harvard Business Review: Entrepreneur's Handbook", 1st Edition, Harvard Business Review Press	**2018**
10.	"Take Me Home", Bansal Rashmi, 1st Edition, Westland.	**2014**
11.	"Intellectual Property Law", Narayanan P., 3rd Edition, Eastern Law House	**2017**
12.	"Intellectual Property Rights", Pandey Neeraj and Dharni Khushdeep, PHI Learning	**2014**
13.	"Intellectual Property Rights", Rosedar S.R.A., LexisNexis (Quick Reference Guide – Q&A Series)	**2016**
14.	MSME Annual Publications (www.msme.gov.in)	**Annual**
15.	WIPO Annual Publications (www.wipo.int)	**Annual**

MOOCs on this course are available at:

1) "Entrepreneurship: Do Your Venture", Available at edx (Offered by IIM Bangalore), Self-Paced (6 weeks).
   https://www.edx.org/course/entrepreneurship-do-your-venture
2) "Becoming an Entrepreneur", Available at edx (Offered by MIT), Self-Paced (6 weeks).
   https://www.edx.org/course/becoming-entrepreneur-mitx-launch-x-4
3) "How to Build a Start-up", Available at Udacity, Self-Paced (One Month).
   https://in.udacity.com/course/how-to-build-a-startup--ep245
4) "Intellectual Property Rights: A Management Perspective, Available at edx (Offered by IIM Bangalore), Starts on 1 August 2018 (6 weeks).
   https://www.edx.org/intellectual-property-rights-a-management-perspective

Course Name	**:**	**Professional Ethics**
Course Code	**:**	**SSM5023**
Credits	**:**	**0.5**
L T P	**:**	**0-1-0**
Segment	**:**	**6-6**

Total No. Tutorials -7

Course Objectives:

	The main objectives of this course are:
4.	To imbibe ethical values and understanding.
5.	To develop moral thinking that will help students to recognize their potential.
6.	To engage and motivate the students to perform ethically in their professional life.

Course Contents:

Sr.No	Course contents	No. of Tutorials
1.	**Introduction to Ethics:** Concept of Ethics – Nature, Scope, Sources, Types, Functions and Factors influencing Ethics, Ethics in Engineering	**2**
2.	**Ethics in Profession:** Concepts of Honesty, Integrity, Reliability, Risk, Safety and Liability, Responsibilities and Rights of Professionals, Professional accountability.	**2**
3.	**Ethics and Business:** Concept of Business Ethics – Nature and Objectives, Ethical dilemmas in business ethics.	**1**
4.	**Self-Development:** Concept of Self-Assessment – SWOT Analysis, Self-Concepts, Self-Confidence, Self-Esteem, Managing Time and Stress, Human values.	**2**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Demonstrate knowledge and better understanding of self and to manage time and stress effectively.
2.	Have subjective well-being.
3.	Have ethical decision making ability in their personal and professional life.

Bibliography:

Sr.No	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1.	"Professional Ethics", Subramaniam R., 2nd Edition, Oxford University Press.	**2017**
2.	"Introduction to Psychology", Kalat James W., 11th Edition, Cengage Learning.	**2017**
3.	"Business Ethics – Text and Cases", Murthy C.S.V., 1st Edition, Himalaya Publishing House.	**2014**
4.	"A Foundation Course in Human Values and Professional Ethics", Gaur R.R., Sangal R. and Bagaria G.P., Excel Books.	**2010**
5.	"Issues and Ethics in the Helping Professions", Corey G., Corey M.S. and Callanan P., 8th Edition, Brooks/Cole, Cengage Learning.	**2010**
6.	"The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Leary M.R., 1st Edition, Oxford University Press.	**2007**
7.	"Business Ethics", Hartman L.P. and Chatterjee A., 3rd Edition, Tata McGraw Hill.	**2006**
8.	"Business Ethics and Professional Values", Rao A.B., Excel Books.	**2006**

9.	"Business Ethics – Concepts and Cases", Velasquez M.G., 5th Edition, Prentice Hall.	**2001**
10.	"Theories of Personality", Hall C.S., Lindzey D. and Cambell J.B., 4th Edition, Hamilton Printing Company.	**1997**

MOOCs on this course are available at:

1) "Ethics in Engineering Practice". Available at SWAYAM(Offered by IIT Kharagpur), 8 weeks, Starts on August 27, 2018.
https://swayam.gov.in/courses/4799-july-2018-ethics-in-engineering-practice

2) "Ethics, Technology and Engineering". Available at Coursera (Offered by EindhovenUniversity of Technology), 8 weeks, Starts on July 16, 2018.
https://www.coursera.org/learn/ethics-technology-engineering

Course Name	:	**Computer Aided VLSI Design**
Course Code	:	**EVM5031**
Credits	:	3
L T P	:	2-0-2
Segment	:	1-6

Total No. Lectures: 28
Total No. of Lab Hrs. : 14

Course Objectives:

The main objectives of this course are:
To provide an introduction to the fundamentals of Computer-Aided Design tools for the modelling, design, analysis, test, and verification of digital Very Large Scale Integration (VLSI) systems.

Course Contents:

Sr. No.	**Course contents (Credits 2.0)**	**No. of Lectures**
1	Front-End Design Hardware Description languages, Verifying behavior prior to system construction simulation and logic verification, Logic synthesis.	5
2	Logic Simulation Logic simulation, compiled and event simulators, relative advantages and disadvantages.	4
3	Logic Synthesis PLA based synthesis and multilevel logic synthesis, Logic Otimization.	4
4	Back-End Design Layout Algorithms Circuit partitioning, placement, and routing algorithms; Design rule verification; Circuit Compaction; Circuit extraction and post layout simulation.	6
5	Fault Detection and Testing in Combinational Circuits Automatic Test Pattern Generation, Algorithms for testing of Combinational circuits, D Algorithm and PODEM Algorithm, Testability measures for combinational circuits.	5
6	Fault Detection and Testing in Sequential Circuits Automatic Test Pattern generation, Scan-based testing of sequential circuits; Testability measures for sequential circuits.	4

Lab Work

Sr. No	**Lab Module (Credits -1.0)**	**No. of Hours**
1.	Experiments based on modelling, design, analysis, test, and verification of digital VLSI systems	14

Course Outcomes:

At the completion of this course, students will be able to:	
	Establish comprehensive understanding of the various phases of CAD for digital electronic systems, from digital logic simulation to physical design, including test and verification.
	Demonstrate knowledge and understanding of fundamental concepts in CAD and to establish capability for CAD tool development and enhancement.

Bibliography:

Sr. No.	Book Detail	Year of Publication
	Algorithms for VLSI Design Automation, S.H. Gerez, Addison-Weseley Longman Singapore Pte Ltd.	2008
	A VHDL Primer- J. Bhaskar.	2001

	Algorithms and Techniques for VLSI Layout Synthesis, Hill, D., D. Shugard, J. Fishburn and K. Keutzer, Kluwer Academic Publishers, Boston.	1989
	Verilog HDL by Samir Palnitkar.	2003
	Computer Aided Design and VLSI Device development, Kit Man Cham, Soo-Young Oh, Daeji Chin, John L. Moll, Springer.	2012

Course Name	**:**	**TESTING & FAULT TOLERANCE**
Course Code	**:**	**EVM5041**
Credits	**:**	**3**
L T P	**:**	**3 0 0**
Segment	**:**	**1-6**

Total No. of Lectures: 42

Course objectives:

The goal of this subject is to enable students to have the knowledge of

- Proper detection of faulty chips after manufacturing
- Test generation for combinational circuits and Design for testability
- Test generation algorithms for sequential circuits
- Built in Self-test and fault tolerance in VLSI chips.

Course Contents:

S. No.	Course Contents	No. of hrs.
1	**Introduction to Testing:** Introduction to Digital VLSI Testing, Functional and Structural Testing, **Structural Testing with Fault Models,** Fault Equivalence, Fault Dominance, Fault Collapsing.	04
2	**Fault Simulation**: Fault Simulation, Circuit Simulation, Serial, Deductive, Parallel, and Concurrent Fault Simulation, Critical Path Tracing.	07
3	**Testability Measures:** SCOAP Rules to Compute Combinational Controllability and Observability.	01
4	**ATPG for Combinational Circuits:** ATPG algebra, D- Algorithm, Boolean difference, Path sensitization, Podem, Random, Deterministic and Weighted Random Test Pattern Generation.	07
5	**PLA and Memory Testing:** PLA Testing, Cross Point Fault Model and Test Generation, Memory Testing - Permanent, Intermittent and Pattern Sensitive Faults, Marching Tests.	09
6	**ATPG for Sequential Circuits**: Time Frame Expansion, Scan Chain Based Testing, BILBO, Boundary Scan for Board Level Testing, Built in Self Test and Totally Self checking Circuits.	09
7	**Fault Tolerance:** Introduction to the concept of Redundancy, Spatial Redundancy, Time Redundancy, Error Correction Codes, Reconfiguration Techniques, Yield Modelling Reliability and Effective Area Utilization.	05

Course outcomes:

At the completion of this course, student will be able to:	
1	Identify the significance of testable design and generate the test pattern for device under test.
2	Analyze fabrication defects, errors and faults.
3	Implement combinational and sequential circuit test generation algorithms.
4	Design the appropriate circuit to embed fault-tolerant techniques.

Books

S. No.	Name of the book/authors/ publisher	Year of publication/reprint
1	Bushnell, M. and Agrawal, V.D., Essentials of Electronic Testing for Digital, Memory and Mixed- Signal VLSI Circuits, Kluwer Academic	2000
2	Abramovici M., Breuer M. A. and Friedman A.D., Digital Systems Testing and Testable Design, Jaico Publishing House	2001
3	Pradhan, D.K., Fault Tolerant Computer System Design, Prentice Hall.	1996
4	Research and Review papers in specific area.	-

Course Name	**:**	**REAL TIME SYSTEMS**
Course Code	**:**	**EVM5301**
Credits	**:**	**1.5**
L T P	**:**	**2-0-2**
Segment	**:**	**1-3**

Total No. of Lectures: 14
Total No. of Lab Hours: 14

Course Objectives:

The main objective of this course is:
Describe what makes a system a real time system.
Explain the presence of and describe the characteristics of latency in real time systems
Summarize special concerns that real time systems present and how these concerns are addressed.

Course Contents:

Sr. No	Course Contents	No. of Lectures
1.	**Introduction (Credits -0.5)** Issues in real time computing, structure of a real time system. task classes. Characterizing real time Systems and tasks: Introduction, performance measures for real time systems: Traditional performance measures, performability, cost functions and hard deadlines.	7
2.	**RTOS and Application design (Credits -0.5)** Real time operating systems, embedded. RTOS, real time process scheduling, structure of real time operating system, memory management in embedded operating system, operating system, overhead inter-process communication mechanisms, file systems in embedded devices, different types of locks, Semaphores. Real Time Communication: Introduction, architectural issues, protocols: deadlines based protocols, hierarchical round robin protocol, token based protocol.	7

Lab Work

Sr. No	Lab Module (Credits -0.5)	No. of Hours
1.	Develop a project using real time processor	14

Course Outcomes

At the completion of this course, students will be able to:	
1	Understand the basics and importance of real-time systems.
2	Generate a high-level analysis document based on requirements specifications
3	Understand basic multi-task scheduling algorithms for periodic, aperiodic, and sporadic tasks as well as understand the impact of the latter two on scheduling.

Bibliography:

Sr.No	Book Details	Year of Publication
1	Embedded System Design by Santanu Chattopadhya, Second Edition.	2013
2	Real-Time Systems, Jane W. S. Liu, Pearson Education Asia	2003
3	Qing Li, Caroline Yao, Real-Time Concepts for Embedded Systems, CRC Press	2003
4	Phillip A. Laplante, Real-Time Systems Design and Analysis, Wiley Publishers 4th edition	2011
5	Research and review papers in specific area	

Course Name	**:**	**Semiconductor Device Modeling**
Course Code	**:**	**EVM5302**
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**1-3**

Total No. Lectures:-14
Total No. of Labs: 14

Course Objectives:

- To provide adequate understanding of semiconductor device modelling aspects, useful for designing devices in electronic, and optoelectronic applications.

Course Contents:

Sr. No	Course Content	No of hrs
1	**Module-1** Introduction to Numerical Modeling: **(Credit- 0.5)** Review of semiconductor equations (Poisson, continuity, drift-diffusion, trap rate). Finite difference formulation of these equations in 1D and 2D. Grid generation; Physical/empirical models of semiconductor parameters (mobility, lifetime, band gap, etc.)	7
2	**Module -2** Quantum Physics Aspects of Device Modeling **(Credit- 0.5)** Effective mass Schrödinger equation, Matrix representation, Dirac notation, WKB Approximation, Time dependent and independent perturbation theories, Fermi's golden rule, semiclassical transport in semiconductors: Boltzmann transport equation, numerical scheme, Introduction to Monte Carlo simulations	7

Lab Work

Sr. No	Lab Module (Credits -0.5)	No. of Hours
1.	Device Modelling And Simulation Lab **(Credit- 0.5)** Modelling and simulation for computation of characteristics of simple devices (p-n junction, MOS capacitor, MOSFET, etc.) using softwares such as SILVACO TCAD.	14

Course Outcomes

Upon successful completion of this course, the enrolled students will be gaining the following knowledge, skills and competences:	
1	An in-depth knowledge of numerical modelling techniques
2	Device design and simulation

Bibliography:

Sr.No	Book Details	Year of Publication
1	Selberherr, S., Analysis and Simulation of Semiconductor Devices, Springer-Verlag	1984
2	Arora, N., MOSFET Models for VLSI Circuit Simulation, Springer-Verlag	1993
3	C.M. Snowden, and, E. Snowden, Introduction to Semiconductor Device Modeling, World-Scientific	1998
4	W.J. McCalla, Fundamentals of Computer-Aided Circuit Simulation, Kluwer Academic	1987
5	Leonard I. Schiff, Quantum Mechanics, Third Edn.,Tata Mc-Graw-Hill	2010
6	Research and Review papers in specific area	

Course Name	**:**	**Thin Film Deposition and Device Fabrication-I**
Course Code	**:**	**EVM5303**
Credits	**:**	**1.5**
L T P	**:**	**3 0 0**
Segment	**:**	**1-3**

Total No. Lectures:-21

Course Objectives:

- To provide knowledge of various material deposition techniques and electronic/VLSI device fabrication technologies.

Course Contents:		
Sr. No.	**Course Contents**	No of hrs
1	**Module-1** Thin Film Deposition **(Credit- 1.0)** Epitaxy and Thin Film Deposition, Film growth: PVD Processes Evaporation (Thermal and ebeam), Chemical Growth Fundamentals of CVD growth Processes, Modern variants: MOCVD, PECVD and ALD Spin Coating	14
2	**Module -2** Lithography and Etching Techniques **(Credit- 0.5)** Optical lithography, resolution and depth of focus, resist processing methods and resolution enhancement, advanced lithography techniques for nanoscale pattering	7

Course Outcomes

Upon successful completion of this course, the enrolled students will be gaining the following knowledge, skills and competences:	
1	An in-depth knowledge of thin film deposition techniques
2	Understand operation of different fabrication tools and etching techniques

Bibliography:

Sr.No	Book Details	Year of Publication
1	Sze, S.M., "VLSI Technology", 4th Ed., Tata McGraw-Hill	1999
2	Chang, C.Y. and Sze, S.M., "ULSI Technology", McGraw-Hill	1996
3	Gandhi, S. K., "VLSI Fabrication Principles: Silicon and Gallium Arsenide", John Wiley and Sons	2003
4	Campbell, S.A., "The Science and Engineering of Microelectronic Fabrication", 4th Ed., Oxford University Press	1996
5	Research and Review papers in specific area	

Course Name	:	**ANALOG CMOS DESIGN I**
Course Code	**:**	**EVM5304**
Credits	**:**	**1.5**
L T P	**:**	**2-0-2**
Segment	**:**	**1-3**

Total No. of Lectures: 14
Total No. of Lab Hours: 14

Course Objectives:

The main objectives of this course are:

- To understand the principles of analog and mixed-signal IC design in CMOS technologies.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	**Basic MOS Device Physics (Credits -0.5)** MOS VI Characteristics, second order effects, short-Channel effects, MOS device models, review of small signal MOS transistor models, and MOSFET noise, analog layout techniques, symmetry, multi-finger transistors.	**7**
2.	**Analog MOS Process (Credits -0.5)** Analog CMOS process (Double Poly Process), Digital CMOS process tailored to analog IC fabrication, fabrication of active devices, passive devices and interconnects, capacitors and resistors, substrate coupling, ground bounce. Single stage amplifiers: Common source stage, source follower, common gate stage, cascode, Folded cascode.	**7**

Lab Work

Sr.No	Lab Module (Credits -0.5)	No. of Hours
1.	Familiarization of Cadence Tool (DC and AC transient analysis of CMOS inverter)	14
2.	Use CADENCE Tool to obtain device characteristics of current mirror and single stage amplifier using CMOS	

Course Outcomes

At the completion of this course, students will be able to:	
1	understand the operation of CMOS devices.
2	understand basics of MOS device physics, different passive devices and single stage amplifiers.

Bibliography:

Sr.No	Book Details	Year of Publication
1	Razavi, B., Design of Analog CMOS Integrated Circuits, Tata McGraw Hill	2008
2	Gregorian, R. and Temes, G.C., Analog MOS Integrated Circuits for Signal Processing, John Wiley.	2004
3	Allen, P.E. and Holberg, D.R., CMOS Analog Circuit Design, Oxford University Press, 2nd Edition	2002
4	Johns, D.A. and Martin, K., Analog Integrated Circuit Design, John Wiley	2008
5	Gray, P.R., Hurst, P.J., Lewis, S.H., and Meyer, R.G., Analysis and Design of Analog Integrated Circuits, John Wiley, 5th edition	2001
6	Hastings, A., The Art of Analog Layout, Prentice Hall	2005
7	Research and review papers in specific area	

Course Name	:	**REAL TIME EMBEDDED SYSTEMS**
Course Code	**:**	**EVM5401**
Credits	**:**	**1.5**
L T P	**:**	**2-0-2**
Segment	**:**	**4-6**

Total No. of Lectures: 14
Total No. of Lab Hours: 14

Course Objectives:

The main objective of this course is:

- To understand what makes a system a real time system
- To understand the characteristics and reasons of latency in real time systems.
- To describe the real concerns that a real time systems present and how these concerns are addressed.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	**Embedded Processing (Credits -0.5)** Introduction to embedded computing, difference between embedded and general purpose computing, characterizing embedded computing, design philosophies, RISC, CISC, VLIW versus superscalar, VLIW versus DSP Processors, register file design, pipeline design, the control unit, control registers, microprocessor versus microcontroller architecture. Embedded Processors : ARM architecture, assembly programming, input output interfacing, GPIO, LCD interfacing, peripherals, DDR memory, SDRAM, interrupts, timers, Intel atom processor, architecture, application development tools	**7**
2.	**System-on-a-Chip (SoC) (Credit 0.5)** System-on-a-Chip (SoC), IP blocks and design reuse, processor cores and SoC, Non-programmable accelerators, reconfigurable logic. Multiprocessing on a chip, symmetric multiprocessing, heterogeneous multiprocessing, in circuit emulation, validation and verification, H/W software partitioning, co-design.	**7**

Lab Work

Sr.No	Lab Module (Credits -0.5)	No. of Hours
1.	Hands on experience on atom boards architecture, application development tools (Hands on Experience on Atom Boards).	14
2.	To program and simulate ARM processor based experiments using flowcode.	

Course Outcomes

At the completion of this course, students will be able to:	
1	Identify the unique characteristics of real time systems
2	Explain the general structure of a real time system
3	Define the unique design problems and challenges of real time systems
4	Program an embedded system

Bibliography:

Sr.No	Book Details	Year of Publication
1	Embedded System Design by Santanu Chattopadhya, Second Edition.	2013
2	Heath, S., Embedded Systems Design, Elsevier Science	2003
3	Fisher, J.A., Faraboschi, P. and Young, C., Embedded Computing -A VLIW Approach to Architecture, Compilers and Tools, Morgan Kaufman	2005
4	Simon, D.E., An Embedded Software Primer, Dorling Kindersley	2005
5	Lori Matassa, Max Domeika, Break Away with Intel Atom Processors: A Guide to Architecture Migration, Intel Press	2010
6	Research and review papers in specific area	

Course Name	**:**	**Nanoelectronic Devices**
Course Code	**:**	**EVM5402**
Credits	**:**	**1.5**
L T P	**:**	**3 0 0**
Segment	**:**	**4-6**

Total No. Lectures:-21

Course Objectives:

- To provide knowledge of device physics/operation, technologies and issues in nanoscale CMOS, other emerging devices and futuristic material based interconnects

Course Contents:		
Sr. No.	**Course Content**	No of hrs
1	**Module-1** Shrink-down Approaches **(Credit- 0.5)** Introduction, CMOS scaling, leakage control and reduction techniques, nanoscale MOSFET, FinFETS, Vertical MOSFETs. system integration limits (interconnect issues etc.)	7
2	**Module -2** Emerging Nanoelectronic Devices **(Credit- 0.5)** Si and hetero-structure nanowire MOSFETs, carbon nanotube MOSFETs, Tunnel FET, quantum wells, quantum wires and quantum dots, Resonant tunneling devices, Single electron transistors	7
3	**Module -3** Emerging Interconnects **(Credit- 0.5)** Optical interconnects, Superconducting interconnects, Nanotechnology interconnects, Silicon nanowires, Carbon nanotube (CNT) and Graphene nanoribbon (GNR) interconnects, performance comparison of CNTs, GNRs and copper interconnects	7

Course Outcomes

Upon successful completion of this course, the enrolled students will be gaining the following knowledge, skills and competences:	
1	An in-depth knowledge of CMOS Scaling.
2	Futuristic material based interconnects such GNRs, CNTs

Bibliography:

Sr.No	Book Details	Year of Publication
1	Philip Wong H. S. and Akinwande Dej, "Carbon nanotube and Graphene Device Physics", Cambridge University Press	2011
2	Diamand Y. S., "Advanced Nanoscale ULSI Interconnects: Fundamentals and Applications", Springer	2009
3	Lundstrom, M., "Nanoscale Transport: Device Physics, Modeling, and Simulation", Springer	2005

4	Wong, B. P., Mittal, A., Cao Y. and Starr, G., “Nano-CMOS Circuit and Physical Design”, Wiley	2004
5	Kundu S., and Sreedhar A. “Nanoscale CMOS VLSI Circuits: Design for Manufacturability” McGraw Hill	2010
6	Research and Review papers in specific area	

Course Name	**:**	**Thin Film Deposition and Device Fabrication-II**
Course Code	**:**	**EVM5403**
Credits	**:**	**1.5**
L T P	**:**	**3 0 0**
Segment	**:**	**4-6**

Total No. Lectures:-21

Course Objectives:

To provide knowledge of various material deposition techniques and electronic/VLSI device fabrication technologies.

Course Contents:

Sr. No.	**Course Contents**	**No. of Hours**
1	**Module–1** Etching Techniques **(Credit- 0.5)** Wet etching, selectivity, isotropy and etch bias, common wet etchants, orientation dependent etching effects; Introduction to plasma technology, plasma etch mechanisms, selectivity and profile control plasma etch chemistries for various films, plasma etch systems.	7
2	**Module– 2** Characterisation Techniques **(Credit- 1.0)** Morphological characterisation: Raman, XRD, SEM, AFM; Electrical Characterisation: Electrical measurement techniques, two probe and four probe measurement technique; RF characterisation	14

Course Outcomes

Upon successful completion of this course, the enrolled students will be gaining the following knowledge, skills and competences:	
1	An in-depth knowledge of thin film deposition techniques
2	Understand operation of different fabrication tools and etching techniques

Bibliography:

Sr.No	Book Details	Year of Publication
1	Sze, S.M., "VLSI Technology", 4th Ed., Tata McGraw-Hill	1999
2	Chang, C.Y. and Sze, S.M., "ULSI Technology", McGraw-Hill	1996
3	Gandhi, S. K., "VLSI Fabrication Principles: Silicon and Gallium Arsenide", John Wiley and Sons	2003
4	Campbell, S.A., "The Science and Engineering of Microelectronic Fabrication", 4th Ed., Oxford University Press	1996
5	Research and Review papers in specific area	

Course Name	:	**ANALOG CMOS DESIGN-II**
Course Code	**:**	**EVM5404**
Credits	**:**	**1.5**
L T P	**:**	**2-0-2**
Segment	**:**	**4-6**

Total No. of Lectures: 14
Total No. of Lab Hours: 14

Course Objectives:

The main objective of this course is:

- To introduce the design of basic analog circuits to provide a foundation for advanced designs.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	**Differential Amplifier (Credits -0.5)** Single ended and differential operation, qualitative and quantitative analysis of differential pair, common mode response, gilbert cell frequency response of amplifiers: Miller effect, association of poles with nodes, frequency response of all single stage amplifiers. Feedback: general considerations, topologies, effect of loading.	**7**
2.	**Operational Amplifier (Credits -0.5)** General considerations, theory and design, performance parameters, single-stage Op Amps, two-Stage Op Amps, design of 2-stage MOS Operational amplifier, gain boosting, comparison of various topologies, slew rate, offset effects, PSRR. Stability and Frequency Compensation: General Considerations, multi-pole systems, phase margin, frequency compensation, compensation techniques.	**7**

Lab Work

Sr. No	**Lab Module (Credits -0.5)**	**No. of Hours**
1.	Introduction to CADENCE (Operating Point Analysis, DC Sweep, Transient Analysis, AC Sweep, Parametric Sweep, Transfer Function Analysis)	14
2	Simulation of discussed devices using Cadence	

Course Outcomes

At the completion of this course, students will be able to:	
1	understand the operation of CMOS devices
2	get familiar with the small- and large-signal models of CMOS transistors,
3	Understand the basic current mirrors, voltage references, and design basic operational amplifiers.
4	Understand the concept of gain, power bandwidth.

Bibliography:

Sr. No	Book Details	Year of Publication
1	Razavi, B., Design of Analog CMOS Integrated Circuits, Tata McGraw Hill	2008
2	Gregorian, R. and Temes, G.C., Analog MOS Integrated Circuits for Signal Processing, John Wiley.	2004
3	Allen, P.E. and Holberg, D.R., CMOS Analog Circuit Design, Oxford University Press, 2nd Edition	2002
4	Johns, D.A. and Martin, K., Analog Integrated Circuit Design, John Wiley	2008
5	Gray, P.R., Hurst, P.J., Lewis, S.H., and Meyer, R.G., Analysis and Design of Analog Integrated Circuits, John Wiley, 5th edition	2001
6	Hastings, A., The Art of Analog Layout, Prentice Hall	2005
7	Research and review papers in specific area	

Course Name	**:**	**NEURAL NETWORKS**
Course Code	**:**	**ECO5001**
Credits	**:**	**1.5**
L T P	**:**	**3 0 0**
Segment	**:**	**1-3**

Total No. of Lectures: 21

Course objectives:

The goals of this course are

- To introduce some of the fundamental techniques and principles of neural computation.
- Basic neural network models, single and multilayer perceptron.
- To investigate some associative Networks
- To investigate some networks based on competition

Course contents:

Sr. No.	Course contents	No of hrs.
1	**Introduction to neural networks:** Introduction to artificial neural networks, biological neural networks, comparison between biological and artificial Neural Networks, terminology and various architectures of Neural Networks, History of Neural Networks, MC Culloch-Pitt Neuron model, various Activation functions.	7
2	**Pattern Classification:** Hebbnet, Biases and threshold, Linear separability, Perceptron, Adaline and Madaline. Architecture, training algorithms and application algorithms of these networks.	7
3	**Pattern Association:** Architecture, Training and application Algorithms for Pattern Association networks, Heteroassociative Memory Neural Network, Auto associative Net, Iterative Auto associative Net, Discrete Hopfield Network, Bidirectional Associative Memory.	7

Course outcomes:

Upon successful completion of this course, the enrolled students will be able to	
1	Implement neural networks for pattern classification.
2	Adequate knowledge about activation functions used for neural networks.
3	Design a fault tolerant neural network for character recognition.

Bibliography:

S. No.	Name of the book/authors/ publisher	Year of publication/reprint
1	Fundamentals of Neural Networks, Laurence Dausett, Pearson Education	2006
2	Neural networks and Fuzzy Logic, K Vinoth Kumar,R. Saravana Kumar, Katson Books	2012
3	Neural Networks and machine learning, Haykin, Pearson Education	2008
4	Neural Networks, Satish Kumar, TMH	2012

Course Name	**:**	**APPLICATIONS OF NEURAL NETWORKS**
Course Code	**:**	**ECO5002**
Credits	**:**	**1.5**
L T P	**:**	**3 0 0**
Segment	**:**	**4-6**

Total No. of Lectures: 21

Course objectives:

The goals of this course are

- To introduce some of neural networks based on competition.
- To introduce adaptive neural network models.
- To investigate networks based on gradient descent rules.
- To investigate some special networks and their applications

Course contents:

Sr. No.	Course contents	No of hrs.
1	**Neural Networks Based On Competition:** Maxnet, Mexican Hat, Hamming Net, Kohonen Self Organizing Maps, Learning Vector Quantization, Full and Forward Counterpropagation. Application based on these networks. Use of Counterpropagation net for a mathematical function.	7
2	**Adaptive and Backpropagation networks:** Adaptive Resonance Theory: Introduction, architecture, algorithm and application of ART1. Backpropagation neural net, architecture, algorithm, variations, applications, derivation of learning rules. Applications based on backpropagation neural net.	7
3	**Fixed Weight Networks:** Fixed-Weight Nets for Constrained Optimization, Neural Net approach to Constrained Optimization, Boltzmann Machine: architecture, algorithm, Travelling Salesman Problem. Examples based on Boltzmann Machine.	7

Course outcomes:

Upon successful completion of this course, the enrolled students will be able to	
1	Application of neural networks to generate functions.
2	Design multilayered neural networks to solve complex problems.
3	Solve complex problems using fixed weight neural networks like Travelling Salesman Problem.

Bibliography:

Sr. No.	Name of the book/authors/ publisher	Year of publication/reprint
1	Fundamentals of Neural Networks, Laurence Dausett, Pearson Education	2006
2	Neural networks and Fuzzy Logic, K Vinoth Kumar,R. Saravana Kumar, Katson Books	2012
3	Neural Networks and machine learning, Haykin, Pearson Education	2008
4	Neural Networks, Satish Kumar, TMH	2012