Ordered List of Electives for all M Tech Branches

Department of Electronics & Communication Engineering

Malaviya National Institute of Technology Jaipur

ECT614	VLSI Technology	3 (3-0-0)
ECT616	Computer Arithmetic & Micro-architecture Design	3 (3-0-0)
ECT618	Graph Algorithms & Combinatorial optimization	3 (3-0-0)
ECT622	System Level Design & Modeling	3 (3-0-0)
ECT624	VLSI Testing & Testability	3 (3-0-0)
ECT626	Formal Verification of Digital Hardware & Embedded Software	3 (3-0-0)
ECT628	Memory design & testing	3 (3-0-0)
ECT630	Advanced Computer Architecture	3 (3-0-0)
ECT632	Embedded SoC & Cyber Physical Systems	3 (3-0-0)
ECT634	Micro-& Nano- electro-mechanical Systems (MEMS & NEMS)	3 (3-0-0)
ECT638	Design of Asynchronous Sequential Circuits	3 (3-0-0)
ECT640	Electronic manufacturing Technology	3 (3-0-0)
ECT642	FPGAs Physical Design	3 (3-0-0)
ECT644	Mixed Signal IC Design	3 (3-0-0)
ECT648	Languages for Hardware Description, Scripting and Simulation	3 (3-0-0)
ECT649	Nanotechnology & Emerging Applications	3 (3-0-0)
ECT652	RF MEMS	3 (3-0-0)
ECT654	RF Integrated Circuits	3 (3-0-0)
ECT655	Optical Codes and Applications	3 (3-0-0)
ECT656	Adaptive Signal Processing	3 (3-0-0)
ECT657	VLSI signal processing architectures	3 (3-0-0)
ECT658	Current-Mode Analog Signal processing	3 (3-0-0)
ECT662	Advance Digital Signal & Image Processing	3 (3-0-0)
ECT664	Estimation and Detection	3 (3-0-0)
ECT666	Optical Networks	3 (3-0-0)
ECT670	Satellite Communication and Radar Engineering	3 (3-0-0)
ECT672	Wireless and Mobile Adhoc Networking	3 (3-0-0)
ECT674	Cryptography	3 (3-0-0)
ECT676	Design of Micro strip Antennas	3 (3-0-0)
ECT678	Design of MICs & MMICs	3 (3-0-0)
ECT680	Advanced Mobile Systems	3 (3-0-0)

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ECT682	Smart and Phased Array Antenna Design	3 (3-0-0)
ECT684	Advanced Topics in Communication	3 (3-0-0)
ECT686	Photonic Integrated Devices and Systems	3 (3-0-0)
ECT688	EMI/EMC	3 (3-0-0)
ECT689	Photonic Switching	3 (3-0-0)
ECT690	Wireless Sensor Networks	3 (3-0-0)
ECT692	Computational Electromagnetics	3 (3-0-0)
ECT694	Advanced Photonic Devices and Components	3 (3-0-0)
ECT696	Telecom Technology & Management	3 (3-0-0)
ECT698	Advanced Networking Analysis	3 (3-0-0)
ECT704	Computer vision	3 (3-0-0)
ECT706	Advanced Embedded software design	3 (3-0-0)
ECT733	Pattern Analysis & Machine intelligence	3 (3-0-0)
ECT734	Internet of Things & IIoT	3 (3-0-0)
ECT735	Probabilistic Machine Learning & AI	3 (3-0-0)
CPT602	Parallel & Distributed Systems	3 (3-0-0)
Optional Electives (Over and Above)		
ECT643	Special modules in VLSI-I	1 (1-0-0)
ECT645	Special modules in VLSI-II	1 (1-0-0)
ECT646	Special modules in VLSI-III	1 (1-0-0)
ECT647	Special modules in VLSI-IV	1 (1-0-0)
ECT761	Special Modules in Embedded Systems Design-I	1 (1-0-0)
ECT762	Special Modules in Embedded Systems Design-II	1 (1-0-0)
ECT763	Special Modules in Embedded Systems Design-III	1 (1-0-0)
ECT764	Special Modules in Embedded Systems Design-IV	1 (1-0-0)
ECT671	Special Modules in ECE - 1	1 (1-0-0)
ECT673	Special Modules in ECE - 2	1 (1-0-0)
ECT675	Special Modules in ECE - 3	1 (1-0-0)
ECT677	Special Modules in ECE - 4	1 (1-0-0)
ECT681	Special Modules in WOC - I	1 (1-0-0)
ECT683	Special Modules in WOC - II	1 (1-0-0)
ECT685	Special Modules in WOC - III	1 (1-0-0)
ECT687	Special Modules in WOC - IV	1 (1-0-0)

Program: M. Tech.	Department: Electronics & Communication Engineering
Course Code: ECT614	**Course Name: VLSI Technology**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Crystal growth & wafer preparation: Processing considerations: Chemical cleaning, getting the thermal Stress factors etc**.**

Epitaxy: Vapors phase Epitaxy Basic Transport processes & reaction kinetics, doping & auto doping, equipments, & safety considerations, buried layers, epitaxial defects, molecular beam epitaxy, equipment used, film characteristics, SOI structure**.[10h]**

Oxidation

Growth mechanism & kinetics, Silicon oxidation model, interface considerations, orientation dependence of oxidation rates thin oxides. Oxides. Oxidation technique & systems dry & wet oxidation. Masking properties of SiO_2**.[56h]**

Diffusion

Diffusion –kinetics, Fick's law, sheet resistivity, methods of diffusion. Diffusion from a chemical source in vapor form at high temperature, diffusion from doped oxide source, diffusion from an ion implanted layer**.[6h]**

Lithography

Optical Lithography: optical resists, contact & proximity printing, projection printing, electron lithography: resists, mask generation. Electron optics: roster scans & vector scans, variable beam shape. X-Ray, e-beam lithography. **[6h]**

Etching

Reactive plasma etching, AC & DC plasma excitation, plasma properties, chemistry & surface interactions, feature size control & apostrophic etching, ion enhanced & induced etching, properties of etch processing. Reactive Ion Beam etching, Specific etches processes: poly/polycide. Trench etching**,[6h]**

Thin Film Materials & their Deposition: Interlayer dielectrics in microelectronic devices, interconnections within and between different electronic devices. **Packaging of Microelectronic Devices:** Packaging materials, different types of packaging, Microelectronic devices reliability. [6h]

References:

1. S. M. Sze, "VLSI Technology", McGraw Hill.
2. May, Sze, "Fundamentals of Semiconductor Fabrication", Wiley
3. Stephen A. Campbell, "The Science and Engineering of Microelectronic Fabrication", Oxford University Press, 1996.
4. Hong Xiao, "Introduction to Semiconductor Manufacturing", Prentice Hall, 2001.
5. SK Gandhi, "VLSI Fabrication Principles", John Wiley 1983.
6. AB Glaser, GE Subak-Sharpe, "Integrated Circuit Engineering", Reading MA, Addison Wesley 1977.
7. D. Nagchoudhuri, "Principles of Microelectronic Technology", Wheeler Publishing, 1998.
8. Plummer, Deal , Griffin, "Slilcon VLSI Technology: Fundamentals, Practice and Modeling" , Pearson
9. Research papers published in Applied Physics Letters and IEEE journals.

Course Outcomes:

CO1 An understanding of silicon and GaAs electronic device fabrication processes
CO2 Learn different types of operations involved in converting silicon wafer into a complex integrated circuit. Learn in detail basics of all operations used to manufacture a silicon-based monolithic integrate circuit.
CO3 Gain experience in the modelling and simulation of semiconductor manufacturing processes.
CO4 Develop an understanding of the working principle and operational details of semiconductor measurement device.

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CO5 Develop an understanding of industrially relevant and research intensive methods of electronic device fabrications. Students should develop understanding of silicon growth methods, thin film growth technologies, lithography and etching processes.

CO6 Become proficient in the measurements of key electrical parameters and characteristics of integrated circuits

Program: M. Tech.	Department: Electronics & Communication Engineering
Course Code: ECT616	Course Name: Computer Arithmetic & Micro-architecture Design
Credit: 3	L-T-P: 3-0-0
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Computer arithmetic- conventional & higher radix number systems, residue & logarithmic number systems; sequential & parallel (and high speed) algorithms for addition, multiplication, division; evaluation of elementary functions- sin, cos, sin-1, cos-1, sinh etc; CORDIC method for trigonometric functions.languages for design description (HDLs) like VHDL or Verilog; Modeling and simulation of circuits at various levels;

Data path design for high performance- pipelining & systolic arrays; Control design- sequential, hardwired & micro-programmed control.

Topics in design-yield and redundancy, Low power design techniques.

References:

For Review

1. Kohavi, Switching & finite automata theory, Mc Graw Hill

Computer arithmetic

2. Ercegovac, Digital Systems, Wiely, 2004
3. Parhami, Computer Arithmetic- Algorithms & Hardware Design, Oxford Univ. Press
4. Koren, Computer Arithmetic Algebra, Prentice Hall Inc.

For Data-path/Control Design

5. Hayes, J P, Computer Architecture & organization, Mc Graw Hill, 2003

For HDLs

6. Navabi. Introduction to VHDL. Mc Graw Hill, 2000
7. Bhaskar. VHDL Primer. Prentice Hall India, 2001
8. Navabi. Verilog digital systems. Mc Graw Hill, 2000
9. Palnitkar, Verilog…., Pearson India/Prentice-Hall India

Low power design

10. Chandrakasan, A. P. Low-power design methodologies. IEEE Press, 1998.
11. Mead & Conway, VLSI circuit design
12. Raguram, R. Modeling and Simulation of Electronic circuits. PHIndia, 1996.
13. Weste and Eshraghian. Principles of CMOS VLSI design. Addison Wesley, 1998.
14. K. Roy and et al, Low power design, Wiley

Course Outcomes:

CO1: To understand the radix number system (Cognitive - understanding)

CO2: To learn the sequential & parallel algorithm for computer arithmetic (Cognitive - understanding)

CO3: To understand the CORDIC method for evaluation of elementary functions (Skills- Analyze)

CO4: To learn basic concepts in HDLs (Skills- Design)

CO5: To understand basics of data path and control path design methods (Skills- design)

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Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT618	**Course Name: Graph Theory and Combinatorial Optimization**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Graph Theory- basics, Planarization, triangulation, graph algorithms for shortest/longest paths, spanning tree, search etc.

Optimization problem- Convex sets and functions. The SIMPLEX algorithm- forms of linear programming problem, geometry of LP, organization of Tableau. Computational considerations

for simplex algorithm

Duality- dual of LP, dual simplex problem. Primal-dual algorithm.

Algorithms & complexity- shortest path, max-flow, Dijkshtra’s algorithm, min-cost flow, algorithm for graph search and matching; spanning trees and matroids; Integer Linear programming, Greedy algorithm, approximation algorithms; branch-and-bound; dynamic programming.

References:

1. Narsingh Deo, Graph theory, Prentice Hall India, 2008.
2. T. H. Cormen, C. E. Leiserson and R. L. Rivest, “Introduction to Algorithms,” McGraw-Hill, 2007
3. S. Baase, Computer algorithms, Pearson India 2008.
4. Papadimitriou and Steiglitz, Combinatorial optimization, PH India, 2001.
5. Nemhauser and Wolsey, Integer and Combinatorial optimization, Wiley Inter-science 1999.

Course Outcomes:

CO1. Is able to grasp and analyze features, properties of graph entities e.g. cutset, tree, chord-set, cycles etc (Cognitive-Analyze)

CO2. Is able to learn & apply graph algorithms and its applications into Circuits, computer problem solving etc. (Skills- Analyze)

CO3. Is able in long perspective, to appreciate the significance of GRAPH as a versatile modeling entitiy; and the significance that it can be used for analysis, problem solving as well as synthesis- especially for chip design, wireless communication protocols & system design, computer problem solving, data structures etc. (Affective/Skills-Evaluate)

CO4. Is able to write small C/C++ programmes related to implementation of graph algorithms (Skills- Apply)

CO5. Is able to write efficient algorithms for graph-search, and other approximation algorithms (Skills, Evaluate)

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Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT622	**Course Name: System Level Design & Modeling**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

UNIT 1. Introduction: Embedded systems, electronic system-level (ESL) design, Models of Computation (MoCs): finite state machines (FSMs), dataflow, process networks, discrete event

UNIT 2. System-level design languages (SLDLs): SpecC, SystemC. System specification, profiling, analysis and estimation. System-level design: partitioning, scheduling, communication synthesis

UNIT 3. System-level modeling: processor and RTOS modeling, transaction-level modeling (TLM) for communication. System-level synthesis: design space exploration (DSE)

UNIT 4. Embedded hardware and software implementation: synthesis and co-simulation, case study. Application specific processors, Retargetable compilers, instruction set-simulation and co-simulation.

UNIT 5. System design examples and case studies. . Recent trends in system level design and modeling

References:

1. Gajski, S. Abdi, A. Gerstlauer, G. Schirner, Embedded System Design: Modeling, Synthesis, Verification,
2. Springer, September 2009. ISBN 978-1-4419-0503-1, ("Orange book", authors' site).
3. Gerstlauer, R. Doemer, J. Peng, D. Gajski, "System Design: A Practical Guide with SpecC",
4. Kluwer Academic Publishers, Boston, June 2001. ISBN 0-7923-7387-1 ("Yellow book")
5. T. Groetker, S. Liao, G. Martin, S. Swan, "System Design with SystemC", Kluwer Academic Publishers, Boston, May 2002. ISBN 1-4020-7072-1 ("Black book")
6. F. Vahid, T. Givargis, "Embedded System Design: A Unified Hardware/Software Introduction" (authors' site),
7. John Wiley & Sons, 2001. ISBN 978-0-471-38678-0

Course Outcomes:

At the end of the course the student will be able to:

CO1- To model a problem at system level (Cognitive- Analyze)

CO2- Realize architecture for a design problem (Skills- Create)

CO3 -To model a system in System C language (Cognitive- Analyze)

CO4 -To generate system interface specifications and perform refinement (Skills- Create)

CO5- To appreciate HW-SW Co-design with latest trends (Cognitive- understanding)

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Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT624	**Course Name: VLSI Testing &Testability**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

UNIT 1. Introduction to VLSI design flow and need of VLSI testing. Physical Faults and their modeling; Stuck at Faults, Bridging Faults; Fault collapsing; Fault Simulation: Deductive, Parallel, and Concurrent Fault Simulation. Critical Path Tracing

UNIT 2. ATPG for Combinational Circuits: D-Algorithm, Boolean Differences, PODEM Random, Deterministic and Weighted Random Test Pattern Generation; Aliasing and its effect on Fault Coverage.

UNIT 3. PLA Testing, Cross Point Fault Model and Test Generation. Memory Testing- Permanent, Intermittent and Pattern Sensitive Faults, Marching Tests; Delay Faults.

UNIT 4. ATPG for Sequential Circuits: Time Frame Expansion ; Controllability and Observability Scan Design, BILBO , Boundary Scan for Board Level Testing ; BIST and Totally self checking circuits.

UNIT 5. System Level Diagnosis & repair- Introduction; Concept of Redundancy, Spatial Redundancy, Time Redundancy, Error Correction Codes. Latest trends in VLSI Testing and Testability

.

References:

1. Abramovici, M., Breuer, M. A. and Friedman, A. D. Digital systems testing and testable design. IEEE press (Indian edition available through Jayco Publishing house), 2001.
2. Bushnell and Agarwal, V. D. VLSI Testing. Kluwer.
3. Agarwal, V. D. and Seth, S. C. Test generation for VLSI chips. IEEE computer society press.
4. Hurst, S. L. VLSI testing: Digital and mixed analog/digital techniques. INSPEC/IEE, 1999.

Course Outcomes:

At the end of the course the student will be able to:
CO1: To able to grasp core concepts of digital system testing and testability. (Cognitive- Understanding)
CO2: To understand how a faulty circuit may cause disasters and affect the nature as well as society. (Affective-Analyze Attitude & Value)
CO3: To understand fault detection using different fault simulation techniques. (Skills- Evaluate)
CO4: To develop ability to design algorithms for automatic test generation for combinational circuits, sequential circuits, PLAs and memory. (Skills/Affective- Create)
CO5: To apply probabilistic approaches for random test generation. (Skills- Apply)
CO6: To apply different redundancy based fault tolerance techniques to increase circuit reliability. (Skill/Affective-Analyze)
CO7: To design BIST for a CUT in Verilog/HDL and implement ATPG algorithms in C/C++/MATLAB. (Skills- Create)

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Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT626	**Course Name: Formal Verification of Digital Hardware & Embedded Software**
Credit: 3	**L-T-P: 2-1-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

UNIT 1. Introduction to Design Verification, OVM and UVM methodology, case studies using Verilog and System Verilog

UNIT 2. Static verification, Formal Verification of digital hardware systems- BDD based approaches, functional equivalence, finite state automata, FSM verification, Model checking

UNIT 3. Various industry & academia CAD tools for formal verification.

UNIT 4. Verification, validation & testing - Debugging techniques for embedded software, instruction set simulators, clear box technique, black box testing, evaluating function test

UNIT 5. Recent trends in Design verification, case study.

References:

1. Embedded systems Design- Artist Roadmap for Research & Development, LNCS-3436, Springer.
2. J. W. Valvano, Eembedded microcomputer systems- Real Time Interfacing, , Thomson press (Cengage India)
3. Computers as components- Principles of embedded computing system design. Wolf, W., Academic Press (Indian edition available from Harcourt India Pvt. Ltd., 27M Block market, Greater Kailash II, New Delhi-110 048.)
4. Verification, validation & testing in software engineering, A. Dasso and A. Funes, Idea Group Inc.
5. Advanced Formal Verification, R. Drechsler, Kluwer.
6. Hardware-Software codesign for data flow dominated embedded systems, R. Niemann, Springer.
7. Readings in Hardware/Software codesign, Micheli, Ernst, Wolf, Morgan Kaufmann.

Course Outcomes:

At the end of the course the student will be able to:
CO1: To understand features of System Verilog (Cognitive- Understanding)

CO2: To study Assertion Based Verification and also be aware of functional coverage. (Cognitive- Analyze/Evaluate)

CO3: To apply language constructs of Bluespec for high level design/synthesis. (Skills- Apply)

CO4: To understand the necessity of the verification methodology. (Affective- understanding)

CO5: Ability to develop the test bench for DUT with verification methodology for scheduling, resource sharing and binding.(Skills- Creativity)

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Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT628	**Course Name: Memory Design & Testing**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Processing technology for Memories: Multipoly Floating Gate and Control Gate, Trench Capacitors and thin Oxide. Memory Modeling and testing faults in SRAMs, Marching Tests; Delay Faults.

Semiconductor memory architecture, Space of memory faults- fault primitives.

Preparation of Circuit Simulation: Definition & location of open, short, and bridge fault, Simulation methodology. Test for single cell and two port SRAMs, Functional fault modeling and testing of RAMS,

Fault Diagnosis & Repair Algorithms.

Built –in self Test and design for testabiltity of RAMs. Built in self repair architecture.

Trend in Embedded Memory testing.

References:

1. Pinaki Mazumder, Kanad Chakraborty, Testing and Testable Design of High-Density Random-Access Memories (Frontiers in Electronic Testing), Kluwer academic pub.
2. Said Hamdioui, Testing Static Random Access Memories: Defects, Fault Models and Test Patterns (Frontiers in Electronic Testing), Kluwer academic pub 2004.
3. Pinaki Mazumder and Kanad Chakraborty, Fault –Tolerence and reliability techniques for High –Density Random- Acess Memories, Pearson India, 2002..

Course Outcomes:

CO1: To know the basics of evaluation of elementary functions (Cognitive- Understand)

CO2: to understand fundamentals of Memory Modeling and testing faults (Cognitive- Understand)

CO3: To learn the techniques and algorithm for testing and fault diagnosis (Skills- Evaluate)

CO4: To understand basics of built-in self test and related issues (Skills- Design)

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Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT630	**Course Name: Advanced Computer Architecture**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

- Advance micro-architecture & Instruction level parallelism- pipelining & superscalar techniques; Instruction formats, instruction sets and their design, Pipelining; dynamic scheduling, VLIW, EPIC;
- Memory hierarchy; Bus cache & shared memory; multilevel cache design & performance; memory systems and error detection and error correction coding;
- Data level parallelism- parallel and superscalar architectures- multivector, SIMD, GPU, CUDA/OpenCL programming etc.; heterogeneous SoC processors;
- Thread level parallelism- scalable multithreaded architectures, Simultaneous muthithread architectures (SMT); multicore; hyper threading; dataflow, cluster architectures. VLIW, RISC,
- parallel program development and environments;

References:

1. D. Patterson and J. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Morgan Kaufmann Publishers, Inc., Second edition, 1998.
2. Computer Architecture: A Quantitative Approach, John L. Hennessy & David A Patterson, Morgan Kaufmann, 1996.
3. Structure Computer Organization, 4th Edition, Andrew S. Tanenbaum, Prentice Hall, 1999.
4. Computer Architecture and Organization, J. Hayes, McGraw Hill, 1988.
5. Computer Organization and Architecture, 5th Edition, William Stallings, Prentice Hall, 1996.

Course Outcomes:

A student who has successfully completed this course should be able to:
CO1: Analyze various performance characteristics of a computer system & trade-offs involved (cognitive- Analyze)
CO2: Apply digital design techniques to the microarchitecture construction of a processor (Skills- Apply)
CO3: understand I/O modules organization and operating system support (Skills- analyze)
CO4: perform the designing of instruction sets architecture (ISA with HW/SW) and evaluate using tools for statistical analysis of instruction set trade-offs (Skills- design)
CO5: Gain the ability to develop parallel GPGPU solutions of CUDA and OpenCL (Skills- analyze)
CO6: Apply knowledge of processor design to improve performance in algorithms and software systems. (Affective-Evaluate)

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Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT632	**Course Name: Embedded SoC & Cyber Physical Systems**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Embedded SoC

Design methodology- high performance embedded computing, and real-time operating system;
HW-SW codesign, FPGA for embedded Systems design, programmable SoC (Zynq SoC); Advanced Computing Models & Architectures
ARM, interfacing, Microkernels and exokernels, monolithic kernels, Domain specific architectures,
Zynq SoC based design methodology- boot image, flash; advanced Cortex™-A9 processor services; DMA controller in the Zynq SoC; Ethernet and USB controllers;
(Optional) Software organization, scheduling, and execution; Energy management and low-power design; Safety and reliability in embedded systems; Emerging Memory Technologies; Fault Resilient Chip Design; Energy Efficient Exascale Systems;

Cyber physical Systems

Algorithms, hardware and software components integration with Internet; conceptual understanding of techniques to translate application non-functional requirements to middleware and hardware functionality, as well as practical implementation of these techniques; Interfacing to the external world through sensors and actuators

(a) Case studies: Low-end systems (medical devices, smart cards, sensors)
(b) Case studies: High-end systems (automobiles, home electronics, robotics)

References:

1. Jonathan W. Valvano, *Embedded Systems: Real-Time Operating Systems for ARM® Cortex™-M Microcontrollers*, Volume 3, Fourth edition, January 2017, ISBN: 978-1466468863. Outline: http://www.ece.utexas.edu/~valvano/arm/outline3.htm
2. Edward Lee and Sanjit Seshia, *Introduction to embedded systems: A cyber-physical systems approach*, MIT Press, 2016. (**Free PDF:** http://leeseshia.org/download.html)
3. Philip Koopman, *Better embedded system software,* Drumnadrochit Education, 2010.
4. *Embedded System Design: A Unified Hardware/Software Introduction*, Frank Vahid and Tony Givargis, John Wiley and Sons, 2001, ISBN No. 04711386782.
5. *High-Performance Embedded Computing: Architectures, Applications, and Methodologies*, Wayne Wolf, Morgan Kaufmann Publishers, 2006, ISBN No. 012369485.
6. J .Fitzgerald, P.G. Larsen, M. Verhoef (Eds.): *Collaborative Design for Embedded Systems: Co-modelling and Co-simulation*. Springer Verlag, 2014, ISBN 978-3-642-54118-6.
7. Suh, S.C., Carbone, J.N., Eroglu, A.E.: *Applied Cyber-Physical Systems.* Springer, 2014.
8. Hennessy and Patterson, Computer Architecture- A Quantitative Approach, 4th or later Edition (ISBN-13: 978-0123704900 ISBN-10: 0123704901 Edition: 4th)

Further reading

1. Edward A. Lee, Cyber-Physical Systems - Are Computing Foundations Adequate?
2. Paulo Tabuada, Cyber-Physical Systems: Position Paper
3. Rajesh Gupta, Programming Models and Methods for Spatio-Temporal Actions and Reasoning in Cyber-Physical Systems
4. E. A. Lee and S. A. Seshia, Introduction to Embedded Systems - A Cyber-Physical Systems Approach, http://LeeSeshia.org, 2011.
5. Altawy R., Youssef A., Security Trade-offs in Cyber Physical Systems: A Case Study Survey on Implantable Medical Devices
6. Ahmad I., Security Aspects of Cyber Physical Systems

7. "US National Science Foundation, Cyber-Physical Systems (CPS)"
8. ^ Jump up to:[a] [b] Khaitan et al., "Design Techniques and Applications of Cyber Physical Systems: A Survey", IEEE Systems Journal, 2014.

Course outcomes:

Is able to:

CO1: Understand significance of embedded HW/SW, computing models & architectures (Cognitive- Understand)

CO2: Understanding of CPU operation, I/O devices and their interfacing (Cognitive- Understand)

CO3: Develop C/C++ programs in real-time operating systems for memory management, interrupt handling, thread management, task scheduling and software/hardware interfacing. (Skills- Apply, Create)

CO4: Learn program and system design and analysis methodologies (Skills- analyze and design)

CO5. Relate to the real-world applications of embedded systems and associate it with emerging areas such as Cyber-Physical Systems (CPS), Internet-of-Things (IoT), and robotics.

Laboratory-

Implement an effective Zynq SoC boot design methodology - Create an appropriate FSBL image for flash; Identify advanced Cortex™-A9 processor services for fully utilizing the capabilities of the Zynq SoC; Analyze the operation and capabilities of the DMA controller in the Zynq SoC; Examine the various Standalone library services and performance capabilities of the Ethernet and USB controllers in the Zynq All Programmable SoC; Describe the Standalone library services available for low-speed peripherals that are contained in the Zynq PS.

Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT634	**Course Name: Micro& Nano Electro Mechanical System (MEMS & NEMS)**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Introduction to MEMS: Introduction: micro- and nano-scale size domains; scaling of physical laws; MEMS materials and processes; Miniaturization Issues. MEMS devices and applications, MEMS Market **[4h].**

MEMS Fabrication Technology: Introduction to Submicron Technology: semiconductor materials; photolithography; doping; thin film growth and deposition; CVD, lithography and Ion Implantation, metallization; wet and dry etching; silicon micromachining; Bulk micromachining; Surface micromachining and LIGA **[4h].**

MEMS Sensors and Actuators (Electrostatic, Thermal, piezoresistive): mechanics including elasticity, beam bending theory, membranes/plates; microactuators based on various principles, electrostatic, thermal, piezoresistive and applications e.g. acceleration, strain, tactile, temperature, IR detector flow; inkjet **[10h].**

MEMS Sensors and Actuators (RF and Bio): MEMS Sensors and Actuators: mechanics including piezoelectric, magnetic, optical and its application. e.g. Microphone, micro speaker, nanogenerator, micro-motor, RF resonator, SAW filter. Materials and processes for BioMEMS, Applications **[10h].**

MEMS Devices Packaging and Calibration: MEMS device Calibration and packaging techniques, Reliability. MEMS software training: COMSOL & Intellisuite [**12h].**

Project

The class project is to design reasonably complex MEMS devices. The project will be performed as a team of two or three students

References:

1. Course notes – will be posted weekly on the course website
2. Foundations of MEMS, Chang Liu, Prentice Hall (2006)
3. Fundamentals of Micro fabrication, Marc Madou, CRC (2002)
4. Introduction to BioMEMS – Albert Folch, CRC (2012)

Course Outcomes:

At the end of the course the student will be able to:
CO1- Gain a knowledge of basic approaches for various MEMS sensors and actuators design. (Cognitive- understaning)
CO2-Capability to critically analyze microsystems technology for technical feasibility as well as practicality. (Affective- Evaluate)
CO3 -Develop efficient design for improving device performance in terms of speed, sensitivity
Selectivity and accuracy. (Skills- Create)
CO4- Design and optimization of RF MEMS sensors and actuators (Skills- Create)
CO5- Design and analysis of efficient MEMS presser sensor. (Skills- Analyze)

DPGC Convener | Head, ECE | SPGB Chairman

Program: M. Tech.	Department: Electronics & Communication Engineering
Course Code: ECT638	**Course Name: Design of Asynchronous Sequential Circuits**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Introduction: Summary of synchronous techniques - disadvantages in today's technology. Advantages of asynchrononous techniques - low power, performance, modularity. Historic difficulties with asynchronous design. Flow Table Reduction, The state-assignment Problem, Delays, Hazards, and Analysis, Feedback, other Modes of operation, Counters.

Circuit Classification*:* Bounded Delay, speed independent, and delay independent. Data models (single-rail, dual-rail). Handshaking protocols (2 phase, 4 phase)

Micropipeline *Circuits*: Basic building blocks. Pipelines, with and without data processing elements. The design of the Amulet processors.

NCL Logic: The NULL convention logic approach. Preserving delay insensitivity, threshold gates with hysteresis.

Formal Aspects of Asynchronous: The Rainbow approach. Green descriptions of micro-pipelines. Overview of formal basis to asynchronous descriptions

References:

1. Asynchronous sequential circuits by Stephen H. Unger, John Wiley & Sons
2. Switching and Finite Automota Theory. Kohavi, Tata McGraw Hill

Course Outcomes:

At the end of the course the student will be able to:

CO1- Gain a knowledge of asynchronous techniques. (Cognitive- understanding)

CO2-Evalvate delays and hazards in asynchronous design. (Affective- Evaluate)

CO3 –Analyze different method for improving digital design. (Skills- analyze)

CO4- Design and optimization of NCL logic. (Skills- Create)

DPGC Convener | Head, ECE | SPGB Chairman

Program: M. Tech.	Department: Electronics & Communication Engineering
Course Code: ECT640	**Course Name: Electronic manufacturing Technology**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Overview of different technologies & future trends- (i) PCB, multilayer PCB, (ii) thin film, (iii) Thick film, (iv) Surface mount devices (v) monolithic- VLSI & MMIC (vi) packaging of semiconductor devices (vii) multichip modules & optoelectronic sub-system packaging (viii) system-on-package (ix) Micro-electro-mechanical systems & NEMS (x) Nanotechnology (xi) standards & procedures- MIL-M- 38510F, MIL-STD-883B, ISO-9000 etc.

References:

1. Manufacturing Technology in the Electronics Industry: An introduction, Edwards P., Springer Netherlands, 1991
2. Handbook of Electronics Manufacturing Engineering, Bernard S. Matisoff, Springer Netherlands, 1991

Course Outcomes:

At the end of the course the student will be able to:

CO1- Gain a knowledge of different PCB layers. (Cognitive- understanding)

CO2- Understand challenges in PCB design technologies. (Cognitive - understanding)

CO3 –Analyze different method for improving packaging of chips. (Skills- analyze)

CO4- Design and optimization of system on package as per industry standards. (Skills- Create)

DPGC Convener Head, ECE SPGB Chairman

Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT642	**Course Name: FPGAs Physical Design**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Introduction to FPGA Architectures.

FPGA design flow, partitioning, placement and routing algorithms.
Technology mapping for FPGAs, case studies.

References:

1. Brown, S. D., Francis, R. J., Rose, J. and Vranesic, Z G. Field programmable Gate arrays. Kluwer, 1992.
2. Betz, V., Rose, J. and Marquardt, A. Architecture and CAD for Deep-submicron FPGAs. Kluwer, 1999.
3. Trimberger, S. M. FPGA Technology. Kluwer, 1992.
4. Oldfield, J. V. and Dorf, R. C. FPGAs: Reconfigurable logic for rapid prototyping and implementation of digital systems. John Wiley, 1995

Course Outcomes:

At the end of the course the student will be able to:

CO1- Gain a knowledge of different FPGA Architectures (Cognitive- understanding)

CO2- Understand challenges in placement and routing algorithms. (Cognitive - understanding)

CO3 –Analyze different method for improving physical design. (Skills- analyze)

CO4- Evaluate Technology mapping for FPGAs (Skills- Evaluate)

Program: M. Tech.	Department: Electronics & Communication Engineering
Course Code: ECT643	Course Name: Special Modules in VLSI - 1
Credit: 3	L-T-P: 3-0-0
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

- Current advances in VLSI Design as defined by instructor- Following is suggested but not restrictive:
  - Novel devices and relevant materials; Device & Technology CAD; Sensors & bio-Sensors

References:

Current literature from quality journals & magazines such as IEEE, ACM, IET etc. & others;

Books on niche areas;

Course Outcomes:

At the end of the course the student will be able to:

CO1: To analyze & implement device design/structure (simulation/fabrication) (Skills, Evaluate)

CO2: To enable her/him to perform research problem solution in a niche & socially relevant area (Affective, creative)

DPGC Convener Head, ECE SPGB Chairman

Program: M. Tech.	Department: Electronics & Communication Engineering
Course Code: ECT644	**Course Name: Mixed Signal IC Design**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Sample and Hold Circuits: Basic S/H circuit, effect of charge injection, compensating for charge injection, bias dependency, bias independent S/H.

D/A Converter: – General considerations, Static non-idealities and Dynamic non-idealities; Current-steering DAC – Binary weighted DAC, Thermometer DAC, Design issues, Effect of Mismatches.

A/D converter: – General considerations, static and dynamic non-idealities. Flash ADC – Basic architecture, Design issues, Comparator and Latch, Effect of non-idealities, Interpolative and Folding architectures. Successive Approximation ADC; Pipeline ADC. Over sampling ADC – Noise shaping, Sigma-Delta modulator.

PLLs: Basic Phase-Locked Loop Architecture, Voltage Controlled Oscillator, Divider Phase Detector, Loop Filer, The PLL in Lock, Liberalized Small-Signal Analysis, Second-Order PLL Model , Limitations of the Second-Order Small-Signal Model, PLL Design Example

References:

1. Behzad Razavi, “Principles of data conversion system design”, S. Chand and company Ltd, 2000
2. Design of Analog CMOS Integrated Circuits: Behzad Razavi Mc Graw Hill Education(India) Edition 2018
3. VLSI Design techniques for Analog and digital Circuits: *R.L. Geiger, P.E. Allen,* D. R. Holberg, OUP, (2/E) *McGraw Hill (2002)*
4. Jacob Baker, "CMOS Mixed-Signal circuit design", A John Willy & Sons, inc., publications, 2003.
5. Analysis And Design Of Analog ICs : Paul R. Gray, Paul J. Hurst Stephen H. Lewis, Robert G. Meyer, J, Willy and Sons, (4/E) (2001)

Course Outcomes:

At the end of the course the student will be able to:

CO1: Understanding working of Sample and Hold Circuits, compensation methods and bias independent design techniques.

CO2: Understanding basics of ADC, various design issues and their mitigation methods.

CO3: Understanding basics of DAC, various design issues and their mitigation methods

CO4: Understanding the PLL principle of operation, working of its component and the effects of the loop components on the system performance

CO5: Design a phase-locked loop for application as a frequency synthesizer, frequency tracking filter, and demodulator for AM, FM.

DPGC Convener | Head, ECE | SPGB Chairman

Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT645	**Course Name: Special Modules in VLSI - 2**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

- Current advances in VLSI Design as defined by instructor- Following is suggested but not restrictive:
    - Circuits- low energy, high performance digital circuits; energy harvesting, sensor conditioning, data conversion, very high speed mixed signal

References:

Current literature from quality journals & magazines such as IEEE, ACM, IET etc. & others;

Books on niche areas;

Course Outcomes:

At the end of the course the student will be able to:

CO1: To analyze & implement high performance analog and digital circuits (simulation/fabrication) (Skills, Evaluate)

CO2: To enable her/him to perform research problem solution in a niche & socially relevant area (Affective, creative)

DPGC Convener Head, ECE SPGB Chairman

Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT646	**Course Name: Special Modules in VLSI - 3**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

- Current advances in VLSI Design as defined by instructor- Following is suggested but not restrictive:
    - Systems- SoC, neuromorphic computing, Ubiquitous computing/wearable computing

References:

Current literature from quality journals & magazines such as IEEE, ACM, IET etc. & others;

Books on niche areas;

Course Outcomes:

At the end of the course the student will be able to:

CO1: To analyze & implement computing methodologies with system perspective (simulation/fabrication) (Skills, Evaluate)

CO2: To enable her/him to perform research problem solution in a niche & socially relevant area (Affective, creative)

DPGC Convener Head, ECE SPGB Chairman

Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT647	**Course Name: Special Modules in VLSI - 4**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

- Current advances in VLSI Design as defined by instructor- Following is suggested but not restrictive:
  - Electronic design Automation- algorithms, methodologies, tools- industrial & open source

References:

Current literature from quality journals & magazines such as IEEE, ACM, IET etc. & others;

Books on niche areas;

Course Outcomes:

At the end of the course the student will be able to:

CO1: To gain hands-on knowledge of EDA tools, techniques and methodologies (simulation/fabrication) (Skills, Evaluate)

CO2: To enable her/him to perform research problem solution in a niche & socially relevant area (Affective, creative)

DPGC Convener Head, ECE SPGB Chairman

Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT648	**Course Name: Languages for Hardware Description, Scripting and Simulation**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

UNIT-I UNIX and SCRIPTING

Introduction to UNIX commands, Handling directories, Filters and Piping, Wildcards and Regular expression, Power Filters and Files Redirection, Working on Vi/Vim/gvim editor, Basic Shell Programming, TCL, Perl and Python Scripting language.

UNIT-II HDL Simulation and Synthesis

Synthesis and simulation using HDLs- Logic synthesis using Verilog. FSM synthesis, Continuation, Data path Synthesis, Performance driven synthesis, Types of simulation, Problem solving, Static timing analysis. Formal verification, Switch level and transistor level simulation, Problem solving, Tutorial.

UNIT-III VLSI Design Verification (Selected Topics)

System Verilog- Introduction- Design hierarchy, Data types, Operators and language constructs, Functional coverage, Assertions, Interfaces and test bench structures, Assertions, Interfaces and test bench structures, OVM, UVM. Discussions.

UNIT-IV Verilog –A and Verilog- AMS

Analog/Mixed Signal Modeling and Verification-Introduction, Analog/Mixed signal modelling using Verilog-A, Analog/Mixed signal modelling using Verilog-AMS, Event Driven Modelling: Real number modelling of Analog/Mixed blocks modelling, Analog/Digital Boundary Issues: boundary issues coverage

UNIT V Advances in Scripting and System design

New softwares/languages recently used in industry. Case studies.

References:

1. S. Sutherland, S. Davidmann, P. Flake, “System Verilog for Design (2/e)” Springer,2006.
2. M.J.S. Smith, “Application Specific Integrated Circuits”, Pearson, 2008.
3. H. Gerez, “Algorithms for VLSI Design Automation”, John Wiley 1999.
4. Recent literature in Electronic Design Automation Tools.
5. Z. Dr Mark, “Digital System Design with SystemVerilog”, Pearson 2010;

Course Outcomes:

At the end of the course the student will be able to:

CO1: execute the special features of VLSI back end and front end CAD tools and UNIX shell script
CO2: design synthesizable Verilog and VHDL code.
CO3: Application of Verilog and system Verilog in digital system
CO4: Model Analog and Mixed signal blocks using Verilog A and Verilog AMS
CO5: Understand the new scripting languages,system design softwares and EDA tools.

DPGC Convener | Head, ECE | SPGB Chairman

Program: M. Tech.	Department: Electronics & Communication Engineering
Course Code: ECT649	**Course Name: Nanotechnology & Emerging Applications**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Introduction: concept of nanotechnology, Origin of nanotechnology: change in optical, mechanical, electronic and magnetic behavior at nanoscale, Advantages of nanostructures in comparison to macrostructures, Scope of nanotechnology. **(4)**

Categories of nanostructures and nanomaterials and their properties: Classification based on dimensionality: zero, one, two and three dimensional nanostructures:-Quantum Dots and Wells, nanowires, nanorods, nanoparticles, thin films, Carbon-based nano materials (buckyballs, nanotubes, graphene), Metallic nano materials (nanogold, nanosilver and metal oxides), Nanocomposites, Nanopolymers, Biological nanomaterials.
(8)

Synthesis of nanostructures and nanomaterials: Synthesis of nanoparticles, nanorods and nanowires, thin films: Ball Milling, Electrodeposition, Spray Pyrolysis, Flame Pyrolysis, Sol-Gel Processing, Solution Precipitation, Molecular Beam Epitaxy (MBE), Metal Nanocrystals by Reduction, Solvothermal Synthesis, Fundamental aspects of VLS and SLS growth, VLS growth of Nanowires, Control of the size of the nanowires, Template based synthesis, Chemical Vapor Deposition (CVD), Metal Oxide - Chemical Vapor Deposition (MOCVD), Physical vapor Deposition (PVD), Chemical vapour Deposition (CVD), DC/RF Magnetron Sputtering, Atomic layer Deposition (ALD).
(9)

Characterization of nanostructures and nanomaterials: Scanning Electron Microscopy (SEM), Field Emission Scanning Electron Microscopy (FESEM), High Resolution Transmission Electron Microscope (HRTEM), Scanning Tunneling Microscope (STM), Atomic Force Microscopy (AFM), X-ray Photoelectron Spectroscopy (XPS), Raman Spectroscopy, Infrared Spectroscopy, X-Ray Diffraction, Photoluminescence Spectroscopy, X-ray Fluorescence Method, Energy Dispersive Analysis of X-rays (EDAX), Thermogravimetry, Differential Thermal Analysis and Differential scanning calorimetry. **(9)**

Applications: Application of nanotechnology in various domains: nano and molecular electronics, nano-devices like FinFETs, Tunnel-FETs, nanochemistry, nanobiotechnology, nanomedicine, nanomagnetism, nanorobotics, nanophotonics, smart nanosensors, MEMS/NEMS, nanotechnololgy for energy systems. **(6)**

References:

1. Nabok A., “Organic and Inorganic Nanostructures”, Artech House, 2005.
2. Dupas C., Houdy P., Lahmani M., “Nanoscience: Nanotechnologies and Nanophysics”, Springer-Verlag Berlin Heidelberg, 2007.
3. Edelstein A S and Cammarata R C, “Nanomaterials: synthesis, Properties and Applictions”,Taylor and Francis, 2012.
4. Michael Wilson, Kamali Kannangara and Geoff Smith, “NANOTECHNOLOGY - Basic Science and Emerging Technologies”, A CRC Press Company, D.C, 2002.;

Course Outcomes:

At the end of the course the student will be able to:

CO1: Knowledge of vast scope and capabilities of nanotechnology (Cognitive- understanding)
CO2: Acquaintance with various kinds of nanostructures and nanomaterials (Cognitive- Analyze)
CO3: Awareness of several kinds of synthesis and characterization techniques for nanostructures and nanomaterials (Cognitive- understanding)
CO4: Knowledge of applications of nanotechnology in various diverse domains.(Skills- Applying)

DPGC Convener   Head, ECE   SPGB Chairman

Program: M. Tech.	Department: Electronics & Communication Engineering
Course Code: ECT652	**Course Name: RF MEMS**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

RF MEMS relays and switches: Switch parameters, Actuation mechanisms, Bistable relays and micro actuators, Dynamics of switching operation.

MEMS inductors and capacitors: Micromachined inductor, Effect of inductor layout, Modeling and design issues of planar inductor, Gap tuning and area tuning capacitors, Dielectric tunable capacitors.

Micromachined RF filters: Modeling of mechanical filters, Electrostatic comb drive, Micromechanical filters using comb drives, Electrostatic coupled beam structures.

MEMS phase shifters: Types, Limitations, Switched delay lines, Micromachined transmission lines, Coplanar lines, Micromachined directional coupler and mixer.

Micromachined antennas: Microstrip antennas – design parameters, Micromachining to improve performance, Reconfigurable antennas.

References:

1. H.J.D.Santos, "RF MEMS Circuit Design for Wireless Communications", Artech House ,2002.
2. G.M.Rebeiz , "RF MEMS Theory , Design and Technology", wiley , 2003.
3. Stephen D Senturia, "Microsystem Design", Kluwer Academic Publishers, 2001.
4. Marc Madou, "Fundamentals of Microfabrication", CRC Press, 1997.
5. V.K.Varadan, K.J Vinoy & K.A. Jose, "RF MEMS and their Applications", Wiley,2003.
6. Gregory Kovacs, "Micromechanised Transducers Source Book", WCB McGraw Hill, Boston, 1998.
7. M H Bao, "Micromechanical Transducers, Pressure Sensors, Accelerometers and Gyroscopes" Elsevier, Newyork, 2000.

Course Outcomes:

At the end of the course the student will be able to:

CO1: Understand various parameters of RF MEMS Switch and its actuation

CO2: Model and design inductor and capacitors

CO3: Design Micromechanical filters

CO4: Understand the various aspects of design of MEMS phase shifters and its application

CO5: Analyze the performance of microstrip antennas

DPGC Convener | Head, ECE | SPGB Chairman

Program: M. Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT654	**Course Name: RF Integrated Circuits**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Fundamental concepts in RF Design – harmonics, gain compression, desensitization, blocking, cross modulation, intermodulation, inter symbol interference, noise figure, Friis formula, sensitivity and dynamic range; Receiver architectures – heterodyne receivers, homodyne receivers, image-reject receivers, digital-IF receivers and subsampling receivers; Transmitter architectures – direct-conversion transmitters, two-step transmitters; Low noise amplifier (LNA) – general considerations, input matching, CMOS LNAs; Down conversion mixers – general considerations, spur-chart, CMOS mixers; Oscillators – Basic topologies, VCO, phase noise, CMOS LC oscillators; PLLs – Basic concepts, phase noise in PLLs, different architectures.

References:

1. Behzad Razavi, RF Microelectronics, Prentice Hall PTR, 1997
2. Thomas H. Lee, The design of CMOS radio-frequency integrated circuit, Cambridge University Press, 2006
3. Chris Bowick, RF Circuit Design, Newnes, 2007.

Course Outcomes:

At the end of the course the student will be able to:

CO1: Knowledge of basic concepts in RF integrated circuit design (Cognitive- understanding)

CO2: Acquaintance with various architectures of receivers and transmitters (Cognitive- Analyze)

CO3: Awareness of several concepts of low noise amplifiers (Cognitive- understanding)

CO4: Knowledge of applications of mixers, oscillators and PLLs. (Skills- Applying)

DPGC Convener | Head, ECE | SPGB Chairman

Program: M. Tech.	Department: Electronics & Communication Engineering
Course Code: ECT656	**Course Name: Adaptive Signal Processing**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Adaptive Filter Structures and Algorithms:

Introduction to Adaptive systems, Adaptive Linear combiner, Minimum Mean-Square Error, Wiener-Hopf Equation, Error Performance Surface, LMS algorithm, Convergence of weight vector, Learning Curve, FX-LMS algorithm (Filtered X-LMS) and its application to ANC, Types of LMS, RLS algorithm, Matrix Inverse Lemma for RLS, Computational complexity of LMS and RLS, Convergence Analysis.

IIR-LMS, Lattice Filter, FIR to Lattice conversion and vice-versa, Adaptive Lattice Filter

Kalman Filter, Adaptive Kalman Filter

Transformed domain adaptive filtering : Block Linear, Block Circular

Filter Banks and multi-rate signal processing

Distributed signal Processing : Incremental LMS, Diffusion LMS

Applications:

Direct Modelling or System Identification, Inverse Adaptive Modelling (Equalization), Adaptive Noise Cancellation, Adaptive filters for time series and stock market prediction, Biomedical Applications (Cancellation of 50-Hz interference in Electro-Cardiography, Cancelling donor heart interference in heart-transplant electrocardiography, Cancelling Maternal ECG in Fetal Electrocardiography), Echo Cancellation in Long distance Telephone Circuits, Adaptive self tuning filter, Adaptive line enhancer, Adaptive filters for classification and data mining.

References:

1. B. Widrow and S. D. Stearns : Adaptive Signal Processing, Prentice Hall.
2. D. G. Manolakis, V. K. Ingle, S. M. Kogon : Statistical and Adaptive Signal Processing, McGraw Hill.
3. S. S. Haykin : Adaptive Filter Theory, 4th Edition, Prentice Hall.
4. A. H. Sayed : Fundamentals of Adaptive Filtering, John Wiley & Sons.

Course Outcomes:

At the end of the course the student will be able to:

CO1 : To learn the characteristics of adaptive system architecture and analyze Wiener-Hopf Equation.
CO2 : To understand the machine learning algorithms including LMS, RLS, Fx-LMS etc.
CO3 : To learn the adaptive structures like : Adaptive Lattice Filter, Kalman Filter, Transformed domain adaptive filtering, Filter Banks.
CO4 : To explore the applications of adaptive signal techniques to System Identification, Channel Equalization, time series prediction etc.
CO5 : To develop MATLAB programming skills for adaptive systems.

DPGC Convener　　　Head, ECE　　　SPGB Chairman

Program: M. Tech.	Department: Electronics & Communication Engineering
Course Code: ECT657	**Course Name: VLSI based Signal Processing Architectures**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Unit 1: **Introduction to VLSI DSP Sytems**

Need of VLSI DSP algorithms. main DSP Blocks and typical DSP Algorithms. Fixed point /Floating point Representation; Floating point Arithmetic Implementation, Architectures of Adders/Multipliers; CORDIC, representation of DSP algorithms: Block Diagram, signal flow graph, data flow graph, dependence graph.

Unit 2**: Iteration Bound**

Data flow graph representations, loop bound and iteration bound, longest path matrix algorithm, iteration bound of Multirate data flow graphs

Unit 3: **Pipelining and Parallel Processing:**

Pipelining and parallel processing of FIR digital filters, pipeline interleaving in digital filters: signal and multichannel interleaving

Unit 4: **Retiming, Unfolding and Folding:**

retiming techniques; algorithm for unfolding, Folding transformation, Techniques of retiming, Unfolding & Folding

Unit 5: **Systolic Array Architecture**

Systolic Array Architecture: Methodology of systolic array architecture, FIR based Systolic Array, Selection of Scheduling Vector, Matrix multiplication of systolic array

Unit 6: **Low power Design**

Theoretical background , Scaling v/s power consumption, power analysis, Power reduction techniques, Power estimation approach

References:

1. VLSI Digital Signal Processing System : : Design and implementation by K.K. Parhi
2. Digital Signal Processing with Field Programmable Gate Arrays Uwe Meyer-Baese , Springer.
3. FPGA-based Implementation of Signal Processing Systems. by Roger Woods, John Mcallister, WILEY

Course Outcomes:

At the end of the course the student will be able to:

CO1: To understand Graphical representation of DSP algorithms and Mapping algorithms into Architectures (Cognitive/Skills- Apply)
CO2: To study architecture for real time systems and parallel and pipelining for Low power design (Cognitive-Remembering)
CO3: To be aware of systolic Array architecture and methodology for developing Architectures (Cognitive-Understanding)
CO4: To know different signal processing modules as convolution technique, retiming concept, folding /unfolding Transformation and CORDIC architecture. (Cognitive- Analyze)
CO5: To implement different low power Design techniques. (Skills- evaluate)

DPGC Convener   Head, ECE   SPGB Chairman

Program: M. Tech.	Department: Electronics & Communication Engineering
Course Code: ECT658	**Course Name: Current-Mode Analog Signal Processing**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Current-mode (CM) Processing, Advantages over voltage-mode processing; Supply-current Sensing, Translinear circuits, Current- feedback opamps, Current Conveyors, Current-mode filters, Log domain filters, Current-mode Instrumentation Amplifiers and Precision Rectifiers, Current-mode Sinusoidal Oscillators and Function Generators, Issues in Current-Output Sensing, Advanced Current-mode building blocks: Current-Controlled Conveyor (CCCII), Current-Differencing Transconductance Amplifier (CDTA), etc. and their applications to high frequency, analog signal processing applications.

References:

1. Esteban Tlelo-Cuautle, "*Integrated Circuits for Analog Signal Processing*," Springer,2012, ISBN: 1461413834, 9781461413837.
2. Chris Toumazou, F. J. Lidgey, David Haigh, "*Analogue IC Design: The Current-mode Approach*," in Circuits, Devices and Systems, Issue 2 of IEE circuits and systems series, IET, 1993, ISBN: 0863412971, 9780863412974.
3. Fei Yuan, "*CMOS Current-Mode Circuits for Data Communications*," in Analog Circuits and Signal Processing, Springer, 2010, ISBN: 1441939997, 9781441939999.
4. P. V. Ananda Mohan, "*Current-Mode VLSI Analog Filters: Design and Applications*," Springer, 2003, ISBN: 0817642773, 9780817642778.
5. Latest research papers on the topics mentioned in the syllabus

Course Outcomes:

At the end of the course the student will be able to:

CO1- Gain a knowledge of different current mode sensing. (Cognitive- understanding)

CO2- Understand challenges in current-mode signal processing technologies. (Cognitive - understanding)

CO3 –Analyze different method for improving current-mode analog circuits. (Skills- analyze)

CO4- Design and optimization of Current-Differencing Transconductance Amplifier. (Skills- Create)

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT655	**Course Name: Optical Codes and Applications**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Introduction: Historical Perspective of Optical Communications, Optical Transmission and Optical Networking, Optical Communications Trends, Migration to 100 Gb/s Ethernet and Beyond.
Optical Coding Schemes: Unipolar and Bipolar codes, 1D time spread codes, phase encoding, spectral amplitude coding, 2D phase-wavelength, wavelength-time and space-time codes, spectral amplitude coding and 3D space-wavelength-time, polarization-wavelength-time and space-wavelength-phase codes. Performance Metrics for comparison of codes: Cardinality, Code dimension, Correlation functions, BER due to multiple access interference, received power & noise.
Enabling Hardware Technologies: Optical encoders/decoders using fiber optic components & integrated optics, Optical AND gate as a decoder, Realization of Optical logic gates, Potential Applications. Latest topics in optical codes and applications

References:

1. Optical code division multiple access: Fundamentals and Applications - Paul R. Prucnal (CRC Press)
2. Optical coding theory with prime - Wing C. Kwong; Guu-Chang Yang (CRC Press)
3. Spreading codes for all-optical code division multiple access communication systems – M. Ravi Kumar (Ph.D. Thesis, IIT Kharagpur)
4. Design and Performance Analysis of a New Family of Wavelength/Time Codes for Fiber-Optic CDMA Networks - E. S. Shivaleela (Ph.D. Thesis, IISc Bangalore)

Course Outcomes:

CO1. Is able to grasp historical perspective and recent trends of Optical Communications including Networking.
CO2. Is able to construct and analyze 1D, 2D and 3D codes.
CO3. Is able to design Optical encoders/decoders using fiber optic components & integrated optic technologies.
CO4. Is able to search and review latest topics.

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT656	**Course Name: Adaptive Signal Processing**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Adaptive Filter Structures and Algorithms:
Introduction to Adaptive systems, Adaptive Linear combiner, Minimum Mean-Square Error, Wiener-Hopf Equation, Error Performance Surface, LMS algorithm, Convergence of weight vector, Learning Curve, FX-LMS algorithm (Filtered X-LMS) and its application to ANC, Types of LMS, RLS algorithm, Matrix Inverse Lemma for RLS, Computational complexity of LMS and RLS, Convergence Analysis.
IIR-LMS, Lattice Filter, FIR to Lattice conversion and vice-versa, Adaptive Lattice Filter
Kalman Filter, Adaptive Kalman Filter
Transformed domain adaptive filtering: Block Linear, Block Circular
Filter Banks and multi-rate signal processing
Distributed signal Processing: Incremental LMS, Diffusion LMS
Applications:
Direct Modelling or System Identification, Inverse Adaptive Modelling (Equalization), Adaptive Noise Cancellation, Adaptive filters for time series and stock market prediction, Biomedical Applications (Cancellation of 50-Hz interference in Electro-Cardiography, Cancelling donor heart interference in heart-transplant electrocardiography, Cancelling Maternal ECG in Fetal Electrocardiography), Echo Cancellation in Long distance Telephone Circuits, Adaptive self-tuning filter, Adaptive line enhancer, Adaptive filters for classification and data mining.

References:

1. B. Widrow and S. D. Stearns: Adaptive Signal Processing, Prentice Hall.
2. D. G. Manolakis, V. K. Ingle, S. M. Kogon : Statistical and Adaptive Signal Processing,
3. McGraw Hill.
4. S. S. Haykin: Adaptive Filter Theory, 4th Edition, Prentice Hall.
5. H. Sayed: Fundamentals of Adaptive Filtering, John Wiley & Sons.

Course Outcomes:

CO1. To learn the characteristics of adaptive system architecture and analyze Wiener-Hopf Equation.
CO2. To understand the machine learning algorithms including LMS, RLS, Fx-LMS etc.
CO3. To learn the adaptive structures like : Adaptive Lattice Filter, Kalman Filter, Transformed domain adaptive filtering, Filter Banks.
CO4. To explore the applications of adaptive signal techniques to System Identification, Channel Equalization, time series prediction etc.
CO5. To develop MATLAB programming skills for adaptive systems.

DPGC Convener Head, ECE SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT662	**Course Name: Advance Digital Signal & Image Processing**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Introduction to Multirate systems and filter banks, 2D systems and mathematical preliminaries, Digital Representation of Binary & Gray Scale and colour Images, Linear operations on images.
Image sampling and quantization: 2D Sampling on rectangular and nonrectangular sampling lattice, Aliasing, Lloyd-Max quantizer etc.
Image Transforms: 2D Discrete Fourier transform, DCT, DST and Hadamard ,Harr K-L Transforms & their applications to image processing.
Image restoration:Wiener filtering , smoothing splines and interpolation.
Image Enhancement Techniques: Gray scale transformation, Histogram matching and equalization, Smoothening:-Noise Removal, Averagins, Median, Min/Max. Filtering sharpening of Images using differentiation, the laplaciam, High Emphasis filtering,
Image analysis: Edge detection, Boundary Lines & Contours.
Image representation by Stochastic models: ARMA models, 2D linear prediction.
Image Segmentation &Thresholding: Multiband Thresholding, Thresholding from Textures, Selective histogram Technique.
Image Compression: Compression Techniques using K-L Transform, Block Truncation Compression. Error free Comprerssion using Huffman coding & Huffman shift coding.

References:

1. Digital Signal Processing- Oppenheim A.V. & Schafer R.W. PHI.
2. Digital Signal Processing-by Mitra- (TATA McGraw Hill) Publications.
3. Digital Image Processing- by Gonzalez / Woods, (Pearson Education)
4. Digital Image Processing- by A.K. Jain
5. Digital Picture Processing- by Rosenfield & Kak

Course Outcomes:

CO1 : Ability to understand Multirate systems , Image sampling and quantization
CO2 : Ability to understand Image Transforms , Image restoration and Image Enhancement Techniques
CO3 : Ability to understand Image analysis , Image Segmentation & Thresholding, Image Compression

DPGC Convener   Head, ECE   SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT664	**Course Name: Estimation and Detection**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Classical Detection Theory:

Decision Theory; Binary Decisions, Gaussian Noise; Detection in Gaussian Noise; Discrete

Representation for Signals; Solution of the Integral Equations; Decisions among a Number of Known Signals, Performance Bounds and Approximations, Detection in Non-white Gaussian Noise
Estimation of Parameters and Random Processes:

The theory of estimation; Bayes estimation; Estimation of (Non-random) signal parameter; Multiple parameter estimation, Estimation Bounds, ML estimation via Expectation-Maximization algorithm, Regularization Joint Estimation and Detection:
Composite Hypotheses, Linear Estimation, Elements of Modern estimation and detection theory (as the time permits).

References:

1. H. L. Van Trees, Detection, Estimation, and Modulation Theory, vol. 1, Wiley Interscience, 2001.
2. C. W. Helstrom, Elements of Signal Detection and Estimation, Prentice Hall, 1995.
3. H. V. Poor, An Introduction to Signal Detection and Estimation, Springer, New York, 1994.

Course Outcomes:

CO1. Master the fundamentals of estimation and detection theory.
CO2. Analyse the performance bounds of various detection schemes.
CO3. Master the estimation schemes using advanced techniques.
CO4. Analyse the strengths and shortcomings of existing estimation and detection techniques.
CO5. Study the state of the art in the estimation and detection.

DPGC Convener   Head, ECE   SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT666	**Course Name: Optical Networks**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Optical Networking: Introduction to circuit switching and packet switching, optical layer, network evolution. Optical networking components/building blocks: Optical fibers, Optical transmitter, receiver and filters, multiplexers, switching elements, wavelength converter, and optical amplifiers. Client layers of the optical layer, WDM network elements.

Optical networks: Basic networks- SONET/ SDH, Fault management, wavelength routed networks, Nonlinear effects on network performance, performance of various systems (WDM DWDM + SOA), Evaluation of crosstalk and dynamics in reconfigurable networks due to power transients and test countermeasures, Technologies (CWDM, PON, ROADM, RSOA) and topologies of access, aggregation and distribution networks

Optical Access Network: Access networks, Photonic packet switching. Deployment considerations. Overview of PON technologies, Ethernet access network, WDM-PON, HFC Systems (Standards: CATV, VDSL), 10-Gigabit Ethernet (xGbE) (Standards: IEEE 802.3.aq), Microwave Photonics and Radio-over-Fiber (RoF) (Standards: IEEE 802.11a/16b, 3GPP UTRAN etc) including schemes for RF-over-Fiber systems carrying wireless formats such as WiFi, WiMax, UMTS, LTE, PON and FTTH (Standards: ITU G 983 & G 984 and IEEE 802.3. ah), Control and management, network survivability, protection schemes

References:

1. C. Sivaramamurthy & M. Gurusamy, WDM Optical Networks, PHI.
2. R. Ramaswami & K. N. Sivarajan, Optical Networks (3/e), Elsevier.

Course Outcomes:

CO1: Appreciate optical switching, network evolution and components
CO2: Evaluate performance of optical networks with non-linear effects
CO3: Implement optical access networks and recent developments

DPGC Convener Head, ECE SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT670	**Course Name: Satellite Communication and Radar Engineering**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

UNIT I: Introduction to satellite communication and different types of orbits; orbital mechanics and parameters
UNIT II: Satellite subsystems, space link design
UNIT III: Multiplexing and access techniques for satellite communication; introduction to spread spectrum; Global navigation satellite systems (GNSS)
UNIT IV: Internet and satellite links; very small aperture antenna; special purpose satellites
UNIT V: Fundamentals of radar systems, Radar modalities, basic operating principles (detection, ranging, Doppler, importance of phase), radar system components

References:

CO1. Introduction to Radar Systems: Merrill I. Skolnik, McGraw-Hill
CO2. Satellite communication systems, B. G. Evans, Published by IET
CO3. Satellite Communication, P. Banerjee, PHI

Course Outcomes:

CO1 : Understand the basic principles of satellite communication.
CO2 : Design the satellite link to fulfil various power requirements Techniques
CO3 : Discuss the multiplexing and multiple access techniques used in satellite and navigation systems.
CO4: Discuss special satellites and their subsystems.
CO5: Explain the basics of radar

DPGC Convener Head, ECE SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT672	**Course Name: Wireless and Mobile Adhoc Networking**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Wireless Communication Standards, Characterization of the Wireless Channel, Receiver Techniques for Fading Dispersive Channels, Mobility Management in Wireless Networks, Mobile IP, Mobile Ad hoc Networks, Ad hoc Routing Protocols, Performance Analysis of DSR and CBRP, Cluster Techniques, Incremental Cluster Maintenance Scheme, Space time Coding for Wireless Communication.

References:

1. Wireless Communication and Networking by John W. Mark, WeihuaZhuang.
2. Wireless Adhoc Networks by M. Ilyas, CRC Press

Course Outcomes:

CO1. To understand the wireless communication standards and characterization of the Wireless Channels.
CO2. To analyze the Mobility Management in Wireless Networks, Mobile IP, Ad hoc routing protocols.
CO3. To understand the Performance Analysis of DSR and CBRP.
CO4. To analyze the Clustering Techniques and Incremental Cluster Maintenance Scheme.

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT674	**Course Name: Cryptography**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Cryptography: Basic Terms and Concepts, Brief History of Cryptography and Cryptanalysis.

Uses and misuses. Basic Number Theory - Divisibility, Primarily, Bases, Congruence's, Modular Arithmetic, GCD'S, Euclidian algorithm, Fermat and Euler Theorems, Finding large primes, Pohlig-Hellman, RSA.

Elementary and Historical Ciphers - Caesar cipher, Transposition and Substitution, Poly- alphabetic ciphers, Product ciphers, DES, IDEA and Exponentiation ciphers. Cipher Modes - Block ciphers, Stream ciphers, Public vs. Private keys, Meet-in-the-middle, LFSRS.

Authentication methods - One-way ciphers, Authentication functions, Message digests, MDS, SHA, Tripwire, Kerberos. Privacy-enhanced communication - Privacy, non-repudiation, Digital signatures, Certificate hierarchies, X.509, PGP, PKI. Introduction to secure transaction standards.

Key Management - Threshold schemes, Random number generation, Key escrow, Key recovery. Applications - Mental Poker, Quadratic residues, Oblivious transfer and Zerknowledge proofs. Digital cash, Digital voting and Contract signing

References:

1. Williain Stallings "Cryptography and Network Security: Principles and Practice", Pearson Education, 2000.
2. KernalTexpalan, "Communication network Management:, PHI, 1992.
3. D.E. Cormer," Computer Networks and Internet", 2nd Edition, Addison Wesley Publication, 2000.
4. Sharma, Vakul, "Handbook of cyber Laws", Macmillan India Ltd, 2002.

Course Outcomes:

CO4. Understand the basics of Cryptography
CO5. Apply number theory concepts to study basic cryptographic algorithms
CO6. Differentiate various algorithms in terms of confidentiality, integrity and authenticity.
CO7. Understand the strengths and weaknesses of various ciphers.
CO8. Apply the concepts learnt to real world scenarios.

DPGC Convener Head, ECE SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT676	**Course Name: Design of Micro strip Antennas**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Fundamental Properties of Single layer Micro strip Patch Antenna. Micro strip Radiators Analytical Models for Micro strip Patch Antennas. Full wave Analysis of Micro strip Patch Antennas.

Rectangular Micro strip Patch Antennas. Circular Dish and Ring Patch Antennas. Circularly Polarized Micro strip Patch Antennas. Enhancing the Bandwidth of Micro strip Patch Antennas.

Improving the Efficiency of Micro strip Patch Antennas.

References:

1. Micro strip Antenna Design Handbook by Ramesh Garg, Prakash Bhartia, Inder Bahl, Apisak Ittipiboon. Artech House.
2. Handbook of Antennas in Wireless Communication by Lal Chand Godara,CRC Press.
3. CAD of Micro strip Antenna for Wireless Applications by Robert A. Sainati, Artech House.
4. Compact and Broadband Micro strip Antenna by Kin-Lu Wong, John Wiley & Sons.
5. Micro strip Patch Antennas by Robert B. Waterhouse, Kluwer academic Publishers.
6. Handbook of Micro strip Antennas by J.R. James and P.S. Hall, Peter Peregrinus Ltd.

Course Outcomes:

CO1. Explain the working principle of microstrip antenna structures
CO2. Analyze different planar antenna geometries
CO3. Design planar antenna structures
CO4. Improve antenna performance parameters

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT678	**Course Name: Design of MICs & MMICs**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Review of fundamentals of electronic conduction in compound semiconductors. Study of semiconductors like GaAs, InP. Fundamentals of band gap engineering. New materials and their growth techniques.

Dielectric material and their properties, thick film and thin film techniques, loss tangent, effective dielectric constant. Effect of dielectric height, metal thickness, width and freq. on dielectric constant.

Two and three terminal devices for MIC and MMIC applications. Study of MESFET and

HEMT performance analysis and biasing arrangements. Review of planar transmission lines, their applications as distributed components. Device and circuit integration techniques, multi-layered structures, probing and coupling techniques, bonding techniques.

CAD for MIC and MMIC, Intr. to nonlinear analysis, synthesis and optimization. Application of foundry design rules, models and design rule checks, layout techniques, process tolerances.

Methods of measurements and testing of MIC and MMIC. Intr. to scalar and network measurements, full nonlinear, harmonic and noise characterization.

Applications of MIC and MMIC as, passive components, switches, mixers, oscillators, amplifiers. Intro. to Quasi-optical systems.

References:

1. Microwave Material and fabrication techniques by Laverghetta, Artech House
2. Microstrip Line and Slot Lines, KC Gupta, R garg, I Bahl, P Bhartia, Artech House
3. Computer Aided Analysis of Nonlinear Microwave Circuits, Paulo JC Rodrigues, Artech House
4. The RF and Microwave Circuit Design Cookbook, SA Mass, Artech House

Course Outcomes:

CO1. Understand the fundamentals of the electric conduction in different semiconductors.
CO2. Identify the appropriate dielectric material for the design of MIC and MMIC.
CO3. Apply transmission lines concept to understand the working of MIC and MMICs.
CO4. Design MIC and MMICs using non-linear synthesis and optimization techniques.
CO5. Characterize the designed MIC and MMIC using advanced measurement techniques.

DPGC Convener   Head, ECE   SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT680	**Course Name: Advanced Mobile Systems**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Operation of Cellular Systems, Frequency reuse concept, Co-channel Interference, Techniques for reducing co-channel interference, Adjacent channel interference, Near end and Far end interference, Crosstalk, interference between systems.

Channel Assignment Techniques, Hand-off Techniques, Concept of smaller Cells, Trunking and Teletraffic Theory

Orthogonal Frequency Division Multiplexing, Orthogonal Frequency Division Multiple Access, MIMO-OFDM, Effect of frequency offset in OFDM, Peak to average power ratio (PAPR) in OFDM.

Cognitive Radio and Software Defined Radio Concepts. Evolution of Mobile Communication Systems, Details of 3G-UMTS, 4G-LTE and 5G Mobile Communication systems.

References:

10. Mobile and Cellular Telecommunication by W C Lee
11. Wireless Communications by T S Rappaport, IEEE Press
12. Wireless and Mobile Communication Systems by D. P. Agarwal & Qing Anzen, Thomson Press

Course Outcomes:

CO1: Appreciate Components of Mobile Communication systems and Operation of cellular system.
CO2: Analyse Interference and Techniques for reducing Co-Channel Interference.
CO3: Evaluate Analog cellular Mobile Systems for Channel structures.
CO4: Design Digital Cellular Mobile Systems, compare the performance of Digital and Analog cellular systems.
CO5: Learn OFDM, OFDMA, MIMO, Cognitive radio systems
CO6: Introduction to 3G-UMTS, 4G-LTE and 5G Mobile Communication systems.

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT682	**Course Name: Smart and Phased Array Antenna Design**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Review of Antenna Theory, Analysis and Design, Introduction, Smart Antenna analogy, Signal Propagation, Strengths and Shortcomings, Beamforming, Mobile Adhoc Networks, Design, Simulation and Results.

Phased Arrays in Radar and Communication Systems: System requirements for radar and communication antennas, Array characterization for radar and communication systems, Fundamental results from array theory, Array size determination, Time-delay compression.

Pattern characteristics of Linear and Planar Arrays: Array analysis, characteristics of linear and planer arrays, Scanning to endfire, Thinned arrays. Pattern Synthesis for Linear and Planar Arrays: Linear arrays and planar arrays with separable distributions, circular planar arrays and adaptive arrays. Electronic Scanning Radar Systems: Frequency and phase scanning, Phase design techniques.

References:

1. Frank Gross, Smart antennas for wireless communications, McGraw-Hill, 2006.
2. R. J. Mailloux, Phased array antenna handbook, Artech house, 2005.
3. R.C. Hansen, Phased Array Antennas, Wiley, 1997.

Course Outcomes:

CO1: Understand and review the basics of the antenna design.
CO2: Understand the working principles of Smart antennas.
CO3: Analyse the phased array antenna systems.
CO4: Synthesize the radiation pattern of phased array antennas.
CO5: Understand the fundamentals of electronic scanning radar systems.

DPGC Convener Head, ECE SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT684	**Course Name: Advanced Topics in Communication**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Advanced topics in: Multiuser Detection Techniques, Wireless Networking, Optical Networking, Signal Processing, Mobile Communication, Computer Networking, and their applications.

References:

1. William Stallings, "Wireless Communications & Networks", ISBN: 0131918354, Prentice Hall; 2nd edition, November 12, 2004.
2. Mobile & Cellular Telecommunication by W.C.Y Lee. McGraw-Hill
3. Digital Signal Processing- Oppenheim A.V. & Schafer R.W. PHI.

Course Outcomes:

CO1: Review the fundamentals of communication technologies.
CO2: Apply the advanced communication topics to real world examples.
CO3: Master the state of the art techniques in the area of communication technologies.
CO4: Apply the mathematics to analyse and design the advanced communication system.
CO5: Develop an ability to read a scientific literature in the advanced communication technologies.

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech (ECE)	Department: Electronics & Communication Engineering
Course Code: ECT686	**Course Name: Photonic Integrated Devices and Systems**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Planar waveguides: Step-index and graded-index waveguides, guided and radiation modes. Strip and channel waveguides, anisotropic waveguides, segmented waveguide; electro-optic and acousto-optic waveguide devices. Directional couplers, optical switch; phase and amplitude modulators, filters, etc. Y-junction, power splitters, Arrayed waveguide devices, fiber pig tailing, Fabrication of integrated optical waveguides and devices. Waveguide characterization, end-fire and prism coupling; grating and tapered couplers, nonlinear effects in integrated optical waveguides.

New materials and process technologies for optical device fabrication, advanced optical sources & detectors, amplifiers, their reliability issues, Polymer waveguides, Surface Plasmon Devices, Optical integrated circuits, hybrid & monolithic systems, optical interconnects, materials and processing for OEIC.

References:

1. Integrated Optics, by Robert G. Hunsperger, Springer
2. Integrated Photonics: Fundamentals, By Ginés Lifante, John Wiley and Sons

Course Outcomes:

CO1. Develop understanding of design concepts related to optical planar waveguides, directional couplers and switches.
CO2. Analyze and Design components such as WDM couplers, filters, isolators, circulators, photonic crystal based waveguides.
CO3. Explore new materials and process technologies for optical device fabrication, reliability issues.
CO4. Develop understanding of design concepts related to hybrid and monolithic systems, optical interconnects.

DPGC Convener　　Head, ECE　　SPGB Chairman

Program: M Tech (ECE)	**Department: Electronics & Communication Engineering**
Course Code: ECT688	**Course Name: EMI/EMC**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Introduction to EMC-EMI standards, EMC Requirements for Electronic Systems, Digital Signal Spectra: Time and Frequency Domain. PCB Track as Transmission Lines, Signal Integrity, Non ideal behavior of Circuit Components, Antennas. Conducted Emissions and Susceptibility, Radiated Emissions and Susceptibility, Crosstalk, Shielding. System Design, Pre-compliance Measurements.

References:

1. Clayton Paul, Introduction to Electromagnetic Compatibility, Wiley
2. Henry W. Ott, Electromagnetic Compatibility Engineering, Wiley.
3. Bogdan Adamczyk, Foundations of Electromagnetic Compatibility: with Practical Applications, Wiley.

Course Outcomes:

CO1. Master the EMI/EMC concepts, terminologies, and compliances.
CO2. Analyze the crosstalk and electromagnetic coupling between various components of electronic system.
CO3. Apply standard EMI Reduction techniques and improve the noise immunity of a system.
CO4. Control and predict the EMI/EMC of a given system.
CO5. Design the appropriate electromagnetic material for a given EMI problem.

DPGC Convener Head, ECE SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT689	Course Name: Photonic Switching
Credit: 3	L-T-P: 3-0-0
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Introduction to Photonic Switching: All Optical Switches, Comparison of OEO and OOO switches, Parameters used for switch performance evaluation, applications of optical Switches, optical cross-connects, protection and restoration, optical Add/Drop multiplexing, optical signal

monitoring, etc.

Switch Types & Structures: Optical Switch Fabrics, Opto-mechanical Switches, Optical Micro Electro-Mechanical Systems (Optical MEMS), Electro-Optic Switches, Thermo-Optic Switches, Liquid-Crystal Switches, Bubble Switches. Acousto-Optic Switches, Semiconductor Optical Amplifier Switches, grated switches and photonic crystal fibre based switches, etc.

Switch Architectures: Introduction to various architectures & algorithms for building large switches, Cross, Clos, Banyan architecture, Benes architecture, Spanke architecture, Spanke- Benes architecture, etc.

Switching in Optical Networks, Opaque Switching, Challenges for Optical Switching, Optical Switching Paradigms, nano photonic switches.

References:

1. Optical Switching by G.I Papadimitriou, C. Papazoglon and A.S Pomportsis, Wiley series in microwave & optical Engg.
2. Optical components for communications by Ching-Fuh Lin, Kluwer academic publishers.
3. Photonics by Ralf Menzel, Springer International Edition.

Course Outcomes:

CO1: Appreciate and evaluate all optical switches
CO2: Design various types of optical switches
CO3: Understand different switch architectures
CO4: Implementation of optical switches in optical networks

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT690	**Course Name: Wireless Sensor Networks**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Network architecture, wireless communication: the physical layer in WSN, WSN medium access control and link layer protocols, WSN services: synchronization and localization, topology control and routing, data-centric and content-based routing, Quality of Service and transport protocols, in-network aggregation and WSN security

References:

1. Murthy &Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols," ISBN 0-13147023-X, Pearson 2004
2. William Stallings, “Wireless Communications & Networks”, ISBN: 0131918354, Prentice Hall; 2nd edition, November 12, 2004.

Course Outcomes:

CO1: Master the fundamentals of wireless sensor network.
CO2: Understand the protocols and their design considerations.
CO3: Model and simulate different WSN parameters.
CO4: Understand the parameters to estimate the QoS.
CO5: Master key routing protocols and the associated design challenges.

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT692	**Course Name: Computational Electromagnetics**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Review of Electromagnetic Theory, Classification of EM Problems. Analytical Methods-

Separation of Variables. Finite Difference Methods. Variation Methods. Method of Moments. Finite element Method.

References:

1. Numerical Techniques in Electromagnetics, by Matthew N.O. Sadiku, CRC Press.
2. Theory and Computation of Electromagnetic Fields by Jianming Jin, Wiley.

Course Outcomes:

CO1: Apply numerical methods in understanding electrostatics and high frequency electromagnetics.
CO2: Evaluate the numerical solution in terms of validity and accuracy.
CO3: Assess the limitations and applicability of the discussed numerical methods.
CO4: Understand the default parameters for efficient usage of commercial solvers.
CO5: Explore independently the scientific literature for state of the art techniques.

DPGC Convener　　　　Head, ECE　　　　SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT694	**Course Name: Advanced Photonic Devices and Components**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Components for Fiber optic Networks- Couplers/Splitters- -semiconductor optical amplifier- bandwidth of SOPA-Polarization dependant gain noise-erbium doped fiber amplifiers- WD multiplexers / demultiplexers- Filters- isolator-circulators- Optical switches-wavelength converters- Fiber gratings-tunable sources, tunable filters.

Photonic crystal structures and devices.

Homo-and hetero-junctions, quantum wells, advanced semi-conductor materials Semiconductor optical amplifiers, LEDs and LDs: Device structure and Characteristics, DFB, DBR, and quantum well lasers, VCSELS & Laser diode arrays.

Computer aided design of integrated optical waveguide devices. Application of photonics to microwave devices. Nonlinear optical waveguides.

Engineering of DWDM systems. ITU standards and nomenclature, channel capacity, bit rate and modulation, network topologies, current performance and future research issues.

References:

1. Fiber Optic Communication systems, G.P.Aggarwal,Wiley Eastern
2. Introduction to Fiber Optics , A.Ghatak and K.Thyagrajan, Cambridge Univ. Press
3. Introduction to Optical Electronics, K.A. Jones, Harper & Row

Course Outcomes:

CO1: Develop understanding of design concepts related to photonic devices and components used in all-optical communication systems.
CO2: Analyze and Design components such as WDM couplers, filters, isolators, circulators, photonic crystal based waveguides.
CO3: Analyze advanced concepts in design of homo and hetero junction devices, quantum well
CO4: structures, DFB/DBR lasers.
CO5: Appreciate the comparative selection of devices for particular applications such as dispersion compensation, switching, multiplexing/demultiplexing, including AWG, diffraction gratings, Bragg gratings.

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT696	**Course Name: Telecom Technology & Management**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Introduction to existing telecommunication technologies GSM, WLL, CDMA, Circuit, packet, frame relay and ATM switching, Broadband ISDN, Evolution of IS-95 and third generation systems,

Microcell networks planning in CDMA, Indoor planning, Sectorization and smart antenna, Tariff rules and guidelines, Comparison of different wireless technologies.

References:

1. W. Stalling, Data Comm. & Networking

Course Outcomes:

CO1: Apply different multiplexing techniques to share network bandwidth
CO2: Identify the design challenged related to indoor communication technologies.
CO3: Understand the role of smart antennas in modern communication technologies.
CO4: Design the efficient strategies for Tariff rules and Guidelines.
CO5: Identify the appropriate network planning strategy for a given design problem.

DPGC Convener Head, ECE SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT698	**Course Name: Advanced Networking Analysis**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Advanced network analysis: Application analysis using the Application form (AAF), Binary-Hex-Decimal conversion, building test packets, Calculating the cost of network problems (Analysis ROI), Key network calculations: Throughput, Latency and Bandwidth, Unattended captures: Triggered starts/stops, Analysis ROI worksheet/calculation.

References:

1. CCNA Portable Command Guide, Second Edition by Scott Empson
2. Network Analysis by Laura Chappell

Course Outcomes:

CO1: Develop and revise the fundamentals of computer networks.
CO2: Build the test packets for advanced analysis techniques.
CO3: Assess the strengths and weakness of various protocols.
CO4: Identify the challenges in managing and configuring switches and routers.
CO5: Analyse the cost of network problems using ROI worksheets.

DPGC Convener   Head, ECE   SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT671	**Course Name: Special Modules in ECE - 1**
Credit: 1	**L-T-P: 1-0-0**
Pre-requisite course: None	
Co-requisite course:	

Syllabus:

- Current advances in Electronics and Communication Engineering as defined by instructor- Following is suggested but not restrictive:

  Optical devices and relevant materials/ Optical Sensors

References:

Current literature from quality journals & magazines such as IEEE, IET etc. & others;

Books on niche areas;

Course Outcomes:

CO1: To analyze & design communication subsystems (simulation/fabrication).

CO2: To enable her/him to perform research problem solution in a niche & socially relevant area

DPGC Convener Head, ECE SPGB Chairman

Program: M.Tech.	Department: Electronics & Communication Engineering
Course Code: ECT673	Course Name: Special Modules in ECE - 2
Credit: 1	L-T-P: 1-0-0
Pre-requisite course: None	
Co-requisite course:	

Syllabus:

Current advances in Electronics and Communication Engineering as defined by instructor- Following is suggested but not restricted

Wireless Communication Technology

References:

Current literature from quality journals & magazines such as IEEE, IET etc. & others;

Books on niche areas;

Course Outcomes:

CO1: To analyze & design communication subsystems (simulation/fabrication).

CO2: To enable her/him to perform research problem solution in a niche & socially relevant area

DPGC Convener Head, ECE SPGB Chairman

Program: M.Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT675	**Course Name: Special Modules in ECE - 3**
Credit: 1	**L-T-P: 1-0-0**
Pre-requisite course: None	
Co-requisite course:	

Syllabus:

- Current advances in Electronics and Communication Engineering as defined by instructor- Following is suggested but not restrictive:
    - VLSI and Embedded Systems

References:

Current literature from quality journals & magazines such as IEEE, IET etc. & others;

Books on niche areas;

Course Outcomes:

CO1: To analyze & design communication subsystems (simulation/fabrication).

CO2: To enable her/him to perform research problem solution in a niche & socially relevant area

DPGC Convener | Head, ECE | SPGB Chairman

Program: M.Tech.	**Department: Electronics & Communication Engineering**
Course Code: ECT677	**Course Name: Special Modules in ECE - 4**
Credit: 1	**L-T-P: 1-0-0**
Pre-requisite course: None	
Co-requisite course:	

Syllabus:

- Current advances in Electronics and Communication Engineering as defined by instructor- Following is suggested but not restrictive:
  - Artificial Intelligence and Machine Learning

References:

Current literature from quality journals & magazines such as IEEE, IET etc. & others;

Books on niche areas;

Course Outcomes:

CO1: To analyze & design communication subsystems (simulation/fabrication).

CO2: To enable her/him to perform research problem solution in a niche & socially relevant area

DPGC Convener   Head, ECE   SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT681	**Course Name: Special Modules in WOC - I**
Credit: 1	**L-T-P: 1-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Current advances in Wireless and Optical Communications as defined by instructor- Following is suggested but not restrictive:

- Optical devices and relevant materials
- Optical Sensors
- Optoelectronics
- Nanophotonics

References:

1. Current literature from quality journals & magazines such as IEEE, IET etc. & others;
2. Books on niche areas;

Course Outcomes:

CO1: To analyze & design devices used in optical communications (simulation/fabrication).
CO2: To enable her/him to perform research problem solution in a niche & socially relevant area

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT683	**Course Name: Special Modules in WOC - II**
Credit: 1	**L-T-P: 1-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Current advances in Wireless and Optical Communications as defined by instructor- Following is suggested but not restrictive:

- Optical Fiber Communications
- Optical Wireless Communications
- LiFi and relevant devices
- LIDAR

References:

1. Current literature from quality journals & magazines such as IEEE, IET etc. & others;
2. Books on niche areas;

Course Outcomes:

CO1: To analyze & design devices used in optical communications (simulation/fabrication).
CO2: To enable her/him to perform research problem solution in a niche & socially relevant area

DPGC Convener Head, ECE SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT685	**Course Name: Special Modules in WOC - III**
Credit: 1	**L-T-P: 1-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Current advances in Wireless and Optical Communications as defined by instructor- Following is suggested but not restrictive:

- 5G Communication Technologies
- Advanced Computational Electromagnetic Techniques
- Future Wireless Communication Transceivers
- Plasmonics and Plasma Sciences

References:

1. Current literature from quality journals & magazines such as IEEE, IET etc. & others;
2. Books on niche areas;

Course Outcomes:

CO1: To analyze & design devices used in optical communications (simulation/fabrication).
CO2: To enable her/him to perform research problem solution in a niche & socially relevant area

DPGC Convener Head, ECE SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT687	**Course Name: Special Modules in WOC - IV**
Credit: 1	**L-T-P: 1-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Current advances in Wireless and Optical Communications as defined by instructor- Following is suggested but not restrictive:

- Wideband Antennas,
- Terahertz Technology
- Millimetre/Sub-millimetre wave communications
- Deep space communications

References:

1. Current literature from quality journals & magazines such as IEEE, IET etc. & others;
2. Books on niche areas;

Course Outcomes:

CO1: To analyze & design devices used in optical communications (simulation/fabrication).
CO2: To enable her/him to perform research problem solution in a niche & socially relevant area

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code:ECT704	**Course Name: Computer Vision**
Credit:3	**L-T-P:3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Unit 1: Overview of image processing systems, image formation and perception, continuous and digital image representation, image quantization, image contrast enhancement, histogram equalization, imaging geometry, cameras and projections, rigid and affine transformations, model of image degradation/restoration process, Image Filtering, Stereo Vision

Unit 2: Feature detection, Interest point detection, edge detection, corner detection, line and curve detection, active contours, SIFT and HOG descriptors, shape context descriptors. Local Image Features and Feature Matching

Unit 3: Object classification and detection, Face detection, Motion Analysis, Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Motion parameter estimation, Kalman filter

Unit 4: Machine learning and deep learning in computer vision, Convolutional Neural Networks, Computer vision applications, Recent research topics in Computer vision, Research Paper review

References:

1. Computer Vision: Algorithms and Applications, by Richard Szeliski
2. Computer Vision: A Modern Approach, Forsyth and Ponce, Pearson Education.
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2008
4. Concise Computer Vision by Reinhard Klette
5. Deep Learning, by Goodfellow, Bengio, and Courville.

Course Outcomes:

At the end of the course students should be able to:

CO1: Describe different image representation, their mathematical representation and different their data structures used. (Cognitive- Remembering, Understanding)

CO2: Implement feature extraction techniques for developing computer vision applications (Skills - Apply, create)

CO3: Recognize the object using the concepts of machine vision (Cognitive + Skill- Analyze)

CO4: Detect a moving object in video using the concepts of motion analysis (Skills- Apply, Evaluate)

CO5: Develop applications using various computer vision techniques. (Affective- Apply, create)

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECP706	**Course Name: Advanced Embedded Software Design**
Credit:3	**L-T-P:3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Processor micro-architecture, application-specific architecture,

Embedded OS, middleware, graphics libraries,

Software Development Tools, graphics IPs, virtual prototyping solutions,

RTOS, Embedded linux, concurrency & concurrent programming languages;

Design automation of such systems including methodologies, techniques and tools for their design as well as novel designs of software components

References:

1. Unix Shell Programming, Kernighan & Pike, PHI
2. Lex & Yacc
3. Linux for Embedded and Real-time Applications, Doug Abbott, Newnes, Elsevier, 2003.
4. An Embedded Software Primer, David E. Simon, Addison Wesley, 1999.
5. Embedded Linux, Pearson.
6. Operating systems principles, Silberchatz, Galvin, Wiley

Course Outcomes:

CO1. Is able to grasp core concepts, basic tenets of micro-architecture vis a vis embedded operating systems, Unix shell programming (Cognitive- understanding) PO1

CO2. Is able to grasp features, properties of Embedded OS(Cognitive- understanding) PO1

CO3. Is able to learn & apply scheduling, deadlock avoidance algorithms and its applications into process scheduling, deadlock avoidance related problem solving etc. (Skills- evaluate) PO2, PO4, PO5, PO11

CO4. Is able in long perspective, to appreciate the significance of virtual memory, file management, security & privacy in OS (Skills- Analyze) PO1, PO4, PO12

CO5. Is able to write programmes for RTOS- scheduling, concurrency, deadlock prevention, etc.; and the significance that it can be used for analysis, problem solving as well as design of OS kernels (Skills- Evaluate) PO5

CO6. Is able to use Embedded OS CAD tools & development environment- VxWorks Windriver, RTLinux, Micrivision (ARM) (Skills- Create) PO2, PO13

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT733	**Course Name: Pattern Analysis & Machine Intelligence**
Credit:3	**L-T-P:3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

UNIT I

Introduction to Pattern Recognition and Machine Learning, ML design cycle, types of learning: supervised, unsupervised and reinforced, introduction to feature extraction and classification, density and discriminant functions, decision surfaces.

Review of probability theory: conditional probability, Bayes theorem, random variables, density and mass functions, expectation and variance, joint distribution function of multiple random variables, multivariate normal distribution.

UNIT II

Bayesian decision theory, Bayes Classifier, Naïve Bayes classifier, Euclidian distance and Mahalanobis distance-based classifiers, minimum-error-rate classification. Parameter estimation methods, Maximum-Likelihood estimation, Gaussian mixture models, Expectation maximization method, Bayesian estimation,

Hidden Markov models for sequential pattern classification: discrete hidden Markov models, continuous density hidden Markov models.

UNIT III

K-nearest neighbour classification: Simple and distance weighed voting approach. Support vector machines: linear SVM, soft-margin approach for non-separable data, kernel trick to learn non-linear SVM, radial basis function, polynomial, and sigmoidal kernel. Decision tree classifier: set of questions, splitting criterion, stop-splitting rule, and class assignment rule in decision tree. Introduction to neural networks: perceptron as linear classifier and multi-layer perceptron. Regression Analysis.

UNIT IV

Feature extraction methods: statistical features, Fourier and wavelet transforms for feature extraction, Data transformation and dimension reduction: Fisher's linear discriminant analysis, Bayesian LDA, step-wise LDA, principal component analysis, kernel-PCA. Optimization in feature selection. Feature visualization.

Ensemble of classifiers. Evaluation the performance of a classifier: holdout, random sampling, and cross validation methods, sensitivity, specificity, confusion matrix and ROC curve. Multi-class classification. Statistical analysis for comparison of significance of multiple classifiers over multiple dataset: Template matching and context dependent classification. The curse of dimensionality.

UNIT V

Unsupervised learning and clustering. Criterion functions for clustering, Prototype-based, Graph-based, Density-based clusters. Algorithms for clustering: K means, DBSCAN, Hierarchical clustering, Cluster validation.

References:

Reference Text-Books

1. R. O. Duda, P. E. Hart and D. G. Stork, **Pattern Classification**, John Wiley, 2001
2. S. Theodoridis and K. Koutroumbas, **Pattern Recognition**, 4th Ed., Academic Press, 2009
3. C. M. Bishop, **Pattern Recognition and Machine Learning**, Springer, 2006
4. T. Pang-Ningm, V. Kumar, M. Steinbach. **Introduction to data mining.** Pearson Education India, 2018.

Programming Books

5. S. Theodoridis *et. al.*, **'Introduction to Pattern Recognition, A MATLAB Approach'**. Academic Press, 2010

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Course Outcomes:

The course equips the students with strong basics in Pattern Recognition and Machine Learning (ML).

CO1: The students would have exposure to different algorithms for learning pattern classification methods and would also have explore to different datasets to get a feel for ML algorithms.

CO2: The statistical and mathematical formulation underlying different algorithms would be understood.

CO3: A background needed to study more advanced topics in ML will be developed (e.g. Deep Learning, Generative Adversarial Networks, etc.).

CO4: The course would help students to build a career in industry using ML, or to be a data scientist, or to pursue research in ML.

DPGC Convener | Head, ECE | SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT 734	**Course Name: Internet of Things & IIoT**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

i) **Introduction to IoT**;

IoT sensors, devices, networks & protocols; Cyber physical Systems

ii) **IoT programming & big data**

Machine-to-Machine Communications; Interoperability in IoT, Introduction to Arduino Programming; Integration of Sensors and Actuators with Arduino; Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi; Data Handling and Analytics, Cloud Computing;

iii) **Cybersecurity & privacy in IoT** (optional)

iv) **Low energy, secure hardware for IoT/sensors**

v) **Global applications** (selected only)

Smart Cities and Smart Homes; Connected Vehicles, Smart transportation; Smart Grid, Industrial IoT; Case Study: Agriculture, healthcare including Smart monitoring of critical diseases & point of care; Activity Monitoring, supply chain & semiconductor manufacturing;

vi) **Industrial IoT (IIoT)**: (selected only)

Enabling Factors; CPS, Energy Market; Example Deployment: Building Automation; Automotive and Transportation; Industrial (Manufacturing); building automation, agriculture, Oil & Gas; RTOS; Network Functions Virtualization; Long-range Wireless Protocols; LoRa WAN; Satellite Communications; ANT+, WiFi, ZigBee, WHART, EnOcean, Z-Wave, NFC; SECURITY: Encryption algorithms- Diffie-Hellman, Encryption Algorithms; Threat Vectors, Attacks: Man-in-the-middle, Replay, Protection Methods, Side-Channel Attacks, Chain of Trust; Hash and MAC Functions; Secure Firmware Updates, Random Number Generation; Predictive and Preventive Maintenance, IIOT deployment and Industrial Internet

References:

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)

Course Outcomes:

CO1. Able to grasp the concept of IoT and embedded systems, cyber physical systems

CO2. Exposing for the end-to-end design of Internet-of-Things applications from sensors to cloud, as well as hardware design/security aspects

CO3. Building in confidence and capability regarding electronics, sensors, and software through hands-on labs.

CO4. Providing exposure to practical problems and their solutions, through case studies using EDA Tools (Electronic Design Automation tools).

CO5. Enhancing the knowledge to Security and privacy needs, and the analysis required to address these needs.

DPGC Convener   Head, ECE   SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT735	**Course Name: Probabilistic Machine Learning and Artificial Intelligence**
Credit:3	**L-T-P:3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Knowledge & Reasoning- Agents, First order logic & inference; Knowledge representation;

Uncertain Knowledge & reasoning- Uncertainty, probabilistic reasoning & reasoning over time; simple & complex decisions;

Learning- Learning from observations, Statistical learning methods, Reinforcement learning;

Applications- Probabilistic language processing, perception, Robotics

AI Fundamentals- Fundamental Concepts of AI: Agents, environments, general model; Problem Solving techniques.

Search Techniques- Uninformed search, heuristic search, adversarial search and game trees; Solution of constraint satisfaction problems using Search.

Knowledge Representation- Propositional and predicate calculus, semantics for predicate calculus, inference rules. reasoning with propositional and predicate logic,

Machine Learning Structures- Supervised and unsupervised learning. Artificial Neural Network (Multi-Layer Perception), Radial Basis Function, Functional Link ANN, Self-Organizing Map, Clustering Adaptive FIR and IIR structures.

Machine Learning - Least Mean Square algorithm, Back Propagation,Genetic algorithm, Algorithms Differential Evolution, Particle Swarm Optimization and Other Nature Inspired Optimization.

Decision under uncertainty; probabilistic inferencing;

Algorithmic models of learning. Learning classifiers, functions, relations, grammars, probabilistic models, value functions, behaviors and programs from experience. Bayesian, maximum a posteriori, and minimum description length frameworks. Parameter estimation, sufficient statistics, decision trees, neural networks, support vector machines, Bayesian networks, bag of words classifiers, N-gram models; Markov and Hidden Markov models, probabilistic relational models, association rules, nearest neighbor classifiers, locally weighted regression, ensemble classifiers. Computational learning theory, mistake bound analysis, sample complexity analysis, VC dimension, Occam learning, accuracy and confidence boosting. Dimensionality reduction, feature selection and visualization. Clustering, mixture models, k-means clustering, hierarchical clustering, distributional clustering. Reinforcement learning; Learning from heterogeneous, distributed, data and knowledge. Selected applications in data mining, automated knowledge acquisition, pattern recognition, program synthesis, text and language processing, internet-based information systems, human-computer interaction, semantic web, and bioinformatics and computational biology.

References:

1. Pattern Recognition and Machine Learning by Chris Bishop
2. Bayesian Data Analysis by Gelman, Carlin, Stern, & Rubin
3. Machine Learning: A Probabilistic Perspective by Kevin Murphy [be sure to get the fourth printing; there were many typos in earlier versions]
4. Bayesian cognitive modeling: A practical course by Michael Lee and Erik-Jan Wagenmakers [electronic version online]
5. Russel Norvig-

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6. Modeling and Reasoning with Bayesian networks by Adnan Darwiche.
7. Pattern Recognition and Machine Learning by Chris Bishop.
8. Machine Learning: a Probabilistic Perspective by Kevin P. Murphy.
9. Information Theory, Inference, and Learning Algorithms by David J. C. Mackay. Available online.
10. Bayesian Reasoning and Machine Learning by David Barber. Available online.
11. Graphical models, exponential families, and variational inference by Martin J. Wainwright and Michael I. Jordan. Available online
12. [CI] Programming Collective Intelligence by Toby Segaran, O'Reilly Media, 2007, ISBN: 0596529325 ˆ
13. [ML] Marsland. (2009). Machine Learning: An Algorithmic Perspective. By Marsland, CRC Press, 2009. ˆ
14. [PY] How to Think Like a Computer Scientist: Learning with Python 2ed by Jerey Elkner, Allen B. Downey and Chris Meyers (Open Book Project) http://www.greenteapress.com/thinkpython/

Course Outcomes:

CO1. Upon completion of this programme, participants will be able to:

CO2. Decide whether AI & ML techniques are applicable for a given business problem and articulate its benefits thereof

CO3. Formulate business problems as AI & ML problem

CO4. Collect data and apply pre-processing techniques

CO5. Apply Supervised Learning, Unsupervised learning, Deep Learning, Visualization techniques

CO6. Identify appropriate techniques to solve the formulated AI & ML problem

CO7. Implement and compare the relevant algorithms using Python

CO8. Interpret and present the predicted model

DPGC Convener Head, ECE SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: CPT602	**Course Name: Parallel & Distributed Systems**
Credit:	**L-T-P:**
Pre-requisite Course:	
Co-requisite Course:	
(To be Borrowed from The Syllabus of M Tech in CSE)	

DPGC Convener Head, ECE SPGB Chairman

Program: M Tech	Department: Electronics & Communication Engineering
Course Code: ECT761	**Course Name: Special Modules in Embedded Systems - 1**
Credit:1	**L-T-P:1-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Current advances in Embedded Systems & IoT as defined by instructor- Following is suggested but not restrictive:

oInternet of everything, industrial IoT, Industry 4.0

References:

Current literature from quality journals & magazines such as IEEE, ACM, IET etc. & others;

Books on niche areas;

Course Outcomes:

CO1: To analyze & implement an IoT device with communication to cloud (simulation/fabrication) (Skills, Evaluate)

CO2: To enable her/him to perform research problem solution in a niche & socially relevant area (Affective, creative)

DPGC Convener Head, ECE SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT762	**Course Name: Special Modules in Embedded Systems - 2**
Credit:1	**L-T-P:1-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Current advances in Embedded Systems & IoT as defined by instructor- Following is suggested but not restrictive:

Cyber physical systems; intelligent systems

Self-aware systems

References:

Current literature from quality journals & magazines such as IEEE, ACM, IET etc. & others;

Books on niche areas;

Course Outcomes:

CO1: To analyze & implement CPS/intelligent systems design/structure (simulation/fabrication) (Skills, Evaluate)

CO2: To enable her/him to perform research problem solution in a niche & socially relevant area (Affective, creative)

DPGC Convener　　　　Head, ECE　　　　SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT763	**Course Name: Special Modules in Embedded Systems - 3**
Credit:1	**L-T-P:1-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Current advances in Embedded Systems & IoT as defined by instructor- Following is suggested but not restrictive:

Computational Intelligence & Linguistics

Probabilistic language processing

References:

Current literature from quality journals & magazines such as IEEE, ACM, IET etc. & others;

Books on niche areas;

Course Outcomes:

CO1: To analyze & implement language translation techniques (simulation/fabrication) (Skills, Evaluate)

CO2: To enable her/him to perform research problem solution in a niche & socially relevant area (Affective, creative)

DPGC Convener　　　　Head, ECE　　　　SPGB Chairman

Program: M Tech	**Department: Electronics & Communication Engineering**
Course Code: ECT674	**Course Name: Special Modules in Embedded Systems - 4**
Credit:1	**L-T-P:1-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Current advances in Embedded Systems & IoT as defined by instructor- Following is suggested but not restrictive:

oHW-SW codesign, FPGA for embedded Systems design, programmable SoC (Zynq SoC); Advanced Computing Models & Architectures

oSafety and reliability in embedded systems; Emerging Memory Technologies; Fault Resilient Chip Design; Energy Efficient Exascale Systems

References:

Current literature from quality journals & magazines such as IEEE, ACM, IET etc. & others;

Books on niche areas;

Course Outcomes:

Course Outcomes:

CO1: To analyze & implement SoC/large system design/structure (simulation/fabrication) (Skills, Evaluate)

CO2: To enable her/him to perform research problem solution in a niche & socially relevant area (Affective, creative)

DPGC Convener Head, ECE SPGB Chairman