

Academic Program: PG

Academic Year 2023-24

Department of Electronics and Communication Engineering

M. Tech in Digital Electronics

I & II Semester Syllabus



**SHRI DHARMASTHALA MANJUNATHESHWARA COLLEGE OF
ENGINEERING & TECHNOLOGY,
DHARWAD – 580 002**

(An Autonomous Institution Approved by AICTE & Affiliated to VTU, Belagavi)

Ph: 0836-2447465

Fax: 0836-2464638

Web: www.sdmcet.ac.in

SDM College of Engineering & Technology, Dharwad

It is certified that the scheme and syllabus for I &II semester M.Tech in Digital Electronics is recommended by the Board of Studies of Electronics and Communication Engineering Department and approved by the Academic Council, SDM College of Engineering &Technology, Dharwad. This scheme and syllabus will be in force from the academic year 2023-24 till further revision.

Chairman BOS & HOD

Principal

**SDM College of Engineering & Technology, Dharwad-02
Department of Electronics & Communication Engineering**

College - Vision and Mission

VISION:

To develop competent professionals with human values.

MISSION:

1. To have contextually relevant Curricula.
2. To promote effective Teaching Learning Practices supported by Modern Educational Tools and Techniques.
3. To enhance Research Culture.
4. To involve Industrial Expertise for connecting classroom content to real life situations.
5. To inculcate Ethics and impart soft-skills leading to overall Personality Development.

SDMCET- Quality Policy

- In its quest to be a role model institution, committed to meet or exceed the utmost interest of all the stake holders.

SDMCET- Core Values

- Competency
- Commitment
- Equity
- Team work and
- Trust

Department - Vision and Mission

VISION:

Fostering excellence in the field of Electronics & Communication Engineering, showcasing innovation, research and performance with continuous Industry – Institute Interaction with the blend of Human values.

MISSION:

M1: To provide quality education in the domain of Electronics & Communication Engineering through state of the art curriculum, **effective teaching learning** process and the best of laboratory facilities.

M2: To encourage **innovation, research** culture and **team work** among students.

M3: **Interact and work** closely with **industries** and **research organizations** to accomplish knowledge at par.

M4: To train the students for attaining **leadership with ethical values** in developing and applying technology for the **betterment of society** and sustaining the global environment.

Program Educational Objectives(PEOs):

1. To equip the students with sound technical knowledge and capability of keeping in pace with changing technology.
2. To develop self confidence for independent working, leadership quality and spirit to work cohesively with group.
3. To inculcate research orientation in the aspect of system design.
4. To imbibe professional and social ethics and to bring awareness regarding societal responsibility, moral and safety related issues.

Program Outcomes (POs):

- PO1:** An ability to independently carry out research /investigation and development work to solve practical problems.
- PO2:** An ability to write and present a substantial technical report/document.
- PO3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
- PO4:** Apply the knowledge of engineering and state of the art technology to solve complex engineering problems.
- PO5:** An ability to identify, formulate and design technically and socially relevant digital electronics systems or processes to meet desired needs within realistic constraints.
- PO6:** Apply professional ethics and engage in independent and life long learning in the broadest context of technological changes.

Scheme for I Semester

Course Code	Course Title	Teaching		Examination				
		L-T-P (Hrs/Week)	Credits	CIE	Theory (SEE)		Practical (SEE)	
				Max. Marks	*Max. Marks	Duration in hours	Max. Marks	Duration in hours
22PRIC100	Research Methodology and IPR	3-0-0	3	50	100	3		
22PDEC100	Applied Mathematics	4-0-0	4	50	100	3		
22PDEC101	Sequential Machines and Fault Analysis	4-0-0	4	50	100	3		
22PDEC102	Digital System Design Using Verilog	4-0-0	4	50	100	3		
22PDEE15X	Elective 1	4-0-0	4	50	100	3		
22PDEL101	Digital Circuits Simulation Laboratory	0-0-3	2	50			50	3
22PDEL102	Seminar	0-0-2	1	50				
Total		19-0-5	22	350	500		50	

Elective 1

22PDEE150	Introduction to Artificial Intelligence & Machine Learning
22PDEE151	IoT Applications
22PDEE152	Nano Electronics

CIE: Continuous Internal Evaluation

SEE: Semester End Examination

L: Lecture

T: Tutorials

P: Practical

* SEE for theory courses is conducted for 100 marks and reduced to 50 marks.

** Classes and evaluation procedures are as per the policy prescribed for online courses by the respective organizations.

Seminar is to be conducted every week and 2-3 students/week will present a topic from emerging areas in respective PG program preferably the contents not studied in their regular courses. The seminar shall be evaluated by 2 faculty members having specialization in respective program and allied areas.

Scheme for II Semester

Course Code	Course Title	Teaching		Examination				
		L-T-P (Hrs/Week)	Credits	CIE	Theory (SEE)		Practical (SEE)	
				Max. Marks	*Max. Marks	Duration in hours	Max. Marks	Duration in hours
22PDEC200	Digital VLSI Design	4-0-0	4	50	100	3		
22PDEC201	Embedded System Design	4-0-0	4	50	100	3		
22PDEE25X	Elective 2	3-0-0	3	50	100	3		
22PDEE25X	Elective 3	3-0-0	3	50	100	3		
22PDEE25X	Elective 4	3-0-0	3	50	100	3		
22PDEL201	VLSI and Embedded Systems Laboratory	0-0-3	2	50			50	3
22PDEL202	Seminar	0-0-2	1	50				
Total		17-0-5	20	350	500		50	

Electives 2 to 4

22PDEE250	Parallel Computing
22PDEE251	Low Power Circuits and Systems
22PDEE252	Data Compression
22PDEE253	Artificial Neural Networks and Deep Learning
22PDEE254	Cryptography
22PDEE255	Wireless Communication Networks
22PDEE256	Micro Electro Mechanical Systems

CIE: Continuous Internal Evaluation

SEE: Semester End Examination

L: Lecture

T: Tutorials

P: Practical

* SEE for theory courses is conducted for **100 marks** and reduced to **50 marks**.

** Classes and evaluation procedures are as per the policy prescribed for online courses by the respective organizations.

Seminar is to be conducted every week and 2-3 students/week will present a topic from emerging areas in respective PG program preferably the contents not studied in their regular courses. The seminar shall be evaluated by 2 faculty members having specialization in respective program and allied areas.

22PRIC100

Research Methodology and IPR

(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The students are expected to learn about the need and types of research, problem formulation, literature review, measurement, scaling, data collection, testing of hypothesis, result interpretation and report writing. Further, the students shall know about the intellectual property rights, copy rights, trademarks, patents, patents filing procedure, infringement & remedies and information technology act etc.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Formulate the research problem, carryout literature survey and decide the methodology.	-	1	-
CO-2	Use measurement and scaling and carryout data collection.	-	1	-
CO-3	Test the hypothesis, interpret & analyze the results and write the report.	2	3	-
CO-4	Explain the need of IPR, copy right, patents, trademarks & the filing procedure and know about infringement, remedies and regulatory framework.	-	2	-

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2	2.5	2	-	-	-

Pre-requisites: Branch specific course on problem analysis (Preferred)

Contents:

1) Research Methodology: Introduction, meaning of research, objectives of research, motivation in research, types of research, research approaches, significance of research, research methods versus methodology, research and

scientific method, importance of knowing how research is done, research process, criteria of good research and problems encountered by researchers in India. **3 Hrs**

Defining the Research Problem: Research problem, selecting the problem, necessity of defining the problem, technique involved in defining a problem, an illustration. **2 Hrs**

- 2) Reviewing the literature:** Importance of the literature review in research, How to review the literature, searching the existing literature, reviewing the selected literature and writing about the literature reviewed. **3 Hrs**

Research Design: Meaning of research design, need for research design, features of a good design, important concepts relating to research design, different research designs, basic principles of experimental designs, important experimental designs. **4 Hrs**

- 3) Measurement and Scaling:** Measurement in research, measurement scales, sources of error in measurement, scaling, meaning of scaling and important scaling techniques **3 Hrs**

Data Collection: Collection of primary data, observation method, interview method, collection of data through questionnaires, collection of data through schedules, difference between questionnaires and schedules, collection of secondary data. **3 Hrs**

- 4) Testing of Hypotheses:** What is a Hypothesis? Basic concepts concerning testing of hypotheses, procedure for hypothesis testing, flow diagram for hypothesis testing, measuring the power of a hypothesis test, tests of hypotheses. **3 Hrs**

- 5) Interpretation and Report Writing:** Meaning of interpretation, technique of interpretation, precaution in interpretation, significance of report writing, different steps in writing report, layout of the research report, types of reports, oral presentation and mechanics of writing a research report, precautions for writing research reports, plagiarism and its significance. **4 Hrs**

- 6) Introduction to Intellectual Property Rights:** Meaning and conception of IPR, competing, rationale for protection, international conventions, world court. **2 Hrs**

Copy right: Historical evolution of the law on copy right, meaning, content, substance, ownership, primary, special rights, obligations, period, assignment and relinquishment of copy rights, License and application for registration of copy right.

Patents: Meaning of Patent, purpose and policy object of patent law, gains to inventor, application of patents, joint application, discovery and invention, patentable and non-patentable inventions, publications and public use, priority date and its purpose, procedure for obtaining patent. Stages of procedure,

refusal to grant patent - consequence, protection period, drafting if claims, grant of patent and significance of date of patent and date of ceiling, Services available with patent office, jurisdiction, appellate authorities, powers and obligations of central government, patent agent and controller – not a civil court.

5 Hrs

Industrial Design: Concepts and Significance

2 Hrs

Trademarks: Definitions and conceptions of Trademark, advantages of registration, marks which are not registrable, known and well-known trade marks, application for registration and procedure for registration, procedure and certification of Trademarks.

2 Hrs

Infringement and Remedies: Meaning of infringement, acts of infringements, suit against infringement and defence against infringement, reliefs and certificate of validity.

2 Hrs

The Information Technology Act: Definitions, certifying authority, meaning of compromise of digital signature, offences and penalties, applicability of IPRs, cybercrimes, adjudicating officer, violation, damages and penalties, Cyber regulation appellate tribunal, World Wide Web and domain names and cyber flying, Self study.

1 Hrs

Reference Books:

- 1) C.R. Kothari, Gaurav Garg, Research Methodology: Methods and Techniques, New Age International, 4th Edition, 2018.
- 2) RanjitKumar, Research Methodology a step-by-step guide for beginners, SAGE Publications, 3rd Edition, 2011.
- 3) Fink A, Conducting Research Literature Reviews: From the Internet to Paper, Sage Publications, 2009.
- 4) N. K. Acharya, Text book on Intellectual Property Rights, 4th Edition, Asia Law House, Hyderabad.

22PDEC100

Applied Mathematics

(4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs): This course will enable students to acquaint with principles of Probability theory, Random process, Linear Algebra, Wavelet transforms Laplace transform and Linear programming problems and apply the knowledge in the applications of Electronics and Communication Engineering Sciences.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in random processes.	-	1,2	-
CO-2	Learn the concept of Wavelets and its Applications to Denoising.	-	1,2	-
CO-3	Apply Linear Algebra, QR and singular value decomposition techniques for data compression, least square approximation in solving inconsistent linear systems.	-	1,2	-
CO-4	Apply transform method to solve one-dimensional wave equation, one-dimensional heat equation, Laplace equation, Poisson equation.	-	1,2	-
CO-5	Solve system of linear and non-linear equation arising in engineering fields	-	1,2	-

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2.0	2.0	-	-	-	-

Pre-requisites: Basics of Probability, Differentiation and Integration, Vectors.

Contents:

- 1) Probability Theory:** Review of basic probability theory. Definitions of random variables and probability distributions, probability mass and density functions, expectation, moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Binomial, Poisson, Exponential, Gaussian and Rayleigh distributions example. **10 Hrs**
- 2) Linear Algebra:** Groups, Fields, Binary Field Arithmetic, Construction of Galois Field and its basic properties. Vectors, matrices, Vector spaces. Computation of Eigen values and Eigen vectors of real symmetric matrices-Given's method. Orthogonal vectors and orthogonal bases, Gram-Schmidt orthogonalization process, QR decomposition, singular value decomposition, least square approximations. **12 Hrs**
- 3) Introduction to Wavelets Theory:** Introduction, The origin of wavelets,

wavelets and other reality transforms. Wavelets in future. Continuous Wavelets: First level of introduction of wavelet transforms. Continuous time frequency representation of signals. Discrete Wavelet Transform signal decomposition (Analysis) frequency response, signal reconstruction. Applications of Wavelets in science and Engineering.

Denoising: Introduction, Denoising using wavelet shrinkage – statistical modelling and estimation, Noise estimation, Denoising Images with MATLAB.

10 Hrs

- 4) Transform Methods:** Laplace transform methods for one dimensional wave equation–Displacement sine string–Longitudinal vibration of a elastic bar, Fourier transform methods for one dimensional heat conduction problems. Fourier transform methods for Laplace equation and Poisson equation. **10 Hrs**
- 5) Linear and Nonlinear Programming:** Simplex Algorithm-Two Phase and Big M techniques-Duality theory-Dual Simplex method, Nonlinear Programming–Constrained extremal problems-Lagranges multiplier method Kuhn-Tucker conditions and solutions. **10 Hrs**

Reference Books:

- 1) Richard Bronson, "Schaum's Outlines of Theory and Problems of Matrix Operations", McGraw-Hill, 1988.
- 2) Venkataraman M K, "Higher Engineering Mathematics", National Pub. Co, 1992.
- 3) Sneddon, I.N., "Elements of partial differential equations", Dover Publications, 2006.
- 4) TahaH A, "Operations research- An Introduction", Mc Milan Publishing Co, 1982.
- 5) K.P. Soman, K.I. Ramachandran, Dr. G. Resmi; Insight into Wavelets (From theory to Practice), PHI Publications, 3rd edition. 2010.

22PDEC101 Sequential Machines and Fault analysis (4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on threshold logic, fault detection and location in combinational circuits. It also covers the detailed sequential machine minimization procedures, state assignments using partitions, machine decomposition, state identification and fault detection experiments for sequential machines.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	List elementary properties of threshold element and logic design of switching circuit by threshold elements	-	4,5	1
CO-2	Explain, analyze and design of different fault detection and fault location experiments for combinational logic circuits and sequential machines.	4,5	3	-
CO-3	Analyze different techniques of failure tolerant design	-	3,4	-
CO-4	Analysis and application of algorithms for Simplification of completely and incompletely specified sequential machines.	-	5	2,6
CO-5	Choose and adapt techniques to decompose the sequential machine into series components, parallel components and to achieve input independency, reduction in the output dependency	4,5	-	2,6
CO-6	Design and Implement homing experiments, distinguishing experiments and machine identification experiments.	-	-	4

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1	2	2	2.2	2.5	1

Pre-requisites: Boolean Algebra, Logic Design

Contents:

- 1) **Threshold Logic:** Introductory Concepts, Synthesis of Threshold Networks **04 Hrs**
- 2) **Reliable Design and Fault Diagnosis Hazards:** Fault Detection in Combinational Circuits, Fault-Location Experiments, Boolean Differences, Fault

Detection by Path Sensitizing, Detection of Multiple Faults, Failure Tolerant Design, Quadded Logic. **15 Hrs**

3) Capabilities, Minimization, and Transformation of Sequential Machines: The Finite- State Model, Further Definitions; Capabilities and Limitations of Finite - State Machines, State Equivalence and Machine Minimization, Simplification of Incompletely Specified Machines. **08 Hrs**

4) Structure of Sequential Machines: Introductory Example, State Assignments Using Partitions, The Lattice of closed Partitions, Reductions of the Output Dependency, Input Independence and Autonomous Clocks, Covers and Generation of closed Partitions by state splitting, Information Flow in Sequential Machines, Decompositions, Synthesis of Multiple Machines. **15 Hrs**

5) State-Identifications and Fault-Detection Experiments: Homing Experiments, Distinguishing Experiments, Machine Identification, Fault-Detection Experiments, Design of Diagnosable Machines, Second Algorithm for the Design of Fault Detection Experiments, Fault-Detection Experiments for Machines which have no Distinguishing Sequences. **10 Hrs**

Activity beyond Syllabus:

Seminar/Demonstration, Case studies on various fault detection techniques.

Reference Books:

- 1) Zvi Kohavi, "Switching and Finite Automata Theory", 2nd Edition. Tata McGraw Hill Edition.
- 2) Charles Roth Jr., "Digital Circuits and logic Design", Thomas Asia Pvt Ltd., Singapore, 6th Edition, 2004.
- 3) Parag K Lala, "Fault Tolerant And Fault Testable Hardware Design", Prentice Hall Inc. 1985
- 4) E. V. Krishnamurthy, "Introductory Theory of Computer", Macmillan Press Ltd, 1983.
- 5) Mishra & Chandrasekaran, "Theory of computer science Automata, Languages and Computation", 2nd Edition, PHI, 2004.

22PDEC102 Digital System Design using Verilog (4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on design of various combinational and sequential circuits and design methodology. It also discusses the implementation of advanced digital circuits on programmable devices of varied complexity.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Explain the basic concepts of digital system design using verilog.	-	4	-
CO-2	Design the real life applications using verilog.	4	5	1
CO-3	Design and Model various sequential circuits and memories using verilog.	4	5	-
CO-4	Describe various programmable Logic Devices.	-	5	-
CO-5	Design processors and controllers using Verilog, for embedded applications.	5	-	6
CO-6	Elaborate different I/O devices and fault modeling techniques.	-	-	6

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1	-	-	2.66	2.25	1

Pre-requisites: Digital Circuit Design, HDL Programming using verilog

Contents:

1) Introduction and Methodology: Digital Systems and Embedded Systems, Binary representation and Circuit Elements, Real-World Circuits, Models, Design Methodology. **Number Basics:** Unsigned and Signed Integers, Fixed and Floating-point Numbers. **12 Hrs**

- 2) **Sequential Basics:** Storage elements, Counters, Sequential Datapaths and Control, Clocked Synchronous Timing Methodology. **10 Hrs**
- 3) **Memories:** Concepts, Memory Types, Error Detection and Correction. **06 Hrs**
- 4) **Implementation Fabrics:** ICs, PLDs, Packaging and Circuit Boards, Interconnection and Signal Integrity. **06 Hrs**
- 5) **Processor Basics:** Embedded Computer Organization, Instruction and Data, Interfacing with memory. **05 Hrs**
- 6) **I/O interfacing:** I/O devices, I/O controllers, Parallel Buses, Serial Transmission, I/O software. **08 Hrs**
- 7) **Design Methodology:** Design flow, Design optimization, Design for test. **05 Hrs**

Reference Books:

- 1) Peter J. Ashenden, “Digital Design: An Embedded Systems Approach Using Verilog”, Elsevier, 2010.
- 2) Charles H. Roth, Jr., Lizy Kurian John, Byeong Kil Lee, “Digital Systems Design Using Verilog”, 1/e, Cengage Learning, 2014.
- 3) Samir Palnitkar, “Verilog HDL”, 2/e, Pearson Education, IEEE 1364-2001Compliant, 2015.
- 4) Nazeih M Botros, “HDL Programming, VHDL and Verilog”, Dreamtech Press, 2007.

22PDEE150	Introduction to Artificial Intelligence & Machine Learning	(4-0-0) 4
------------------	---	------------------

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on introduction to the fundamental concepts in artificial intelligence & machine learning. Topics covered include linear modeling, Bayesian approach, classification, clustering and popular machine learning algorithms in each topic. The course also discusses various issues related to the application of artificial intelligence using machine learning techniques.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs (1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Recognize the characteristics of artificial intelligence systems that make it useful to real-world problems	-	3,1	2

CO-2	Analyze the situations of applying variety of mathematical models and algorithms for machine learning	3	1	-
CO-3	Compare and justify various mathematical models and algorithms used in machine learning	4,1	3	2
CO-4	Justify the selection of various classification and regression supervised/unsupervised learning problems of machine learning	-	3,1	-
CO-5	Select and implement machine learning techniques that are suitable for the applications under consideration	4	3,1	-
CO-6	Evaluate the performance of various machine learning algorithms	-	3	1

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2.0	1.0	2.2	3.0	---	----

Pre-requisites: Basics of probability and statistics, Linear algebra

Contents:

- 1) **Introduction to Artificial Intelligence:** History of artificial intelligence, Propositional logic; basics of propositional logic, Resolution, Artificial intelligence applications, First order logic; basics of first order logic, certain knowledge representation; Taxonomic knowledge, Frames, Nonmonotonic logic. **08 Hrs**
- 2) **Linear Modeling-A Least Squares Approach:** Linear Modeling, Making Predictions, Vector/Matrix Notation, Non-Linear Response from a Linear Model, Generalization and Over-Fitting, Regularized Least Squares. **05 Hrs**
- 3) **Linear Modeling-A Maximum Likelihood Approach:** Errors as Noise, Random Variables and Probability, Popular Discrete Distributions, Continuous Random Variables - Density Functions, Popular Continuous Density Functions, Likelihood, The Bias-Variance Trade-off, Effect of Noise on Parameter Estimates, Variability in Predictions. **09 Hrs**
- 4) **The Bayesian Approach to Machine Learning:** A Coin Game, Exact Posterior,

The Three Scenarios, Marginal Likelihoods, Hyper parameters, Graphical Models, A Bayesian Treatment of the Olympic100m Data, Marginal Likelihood for Polynomial Model Order Selection. **09 Hrs**

5) Bayesian Inference: Non-Conjugate Models, Binary Responses, A Point Estimate - The Map Solution, The Laplace Approximation, Sampling Techniques. **08 Hrs**

6) Classification: The General Problem, Probabilistic Classifiers, Non-Probabilistic Classifiers, Assessing Classification Performance, Discriminative and Generative Classifiers. **05 Hrs**

7) Clustering: The General Problem, K-Means Clustering, Mixture Models. **08 Hrs**

Activity beyond Syllabus: Program development for the machine learning Algorithms in MATLAB/ Python.

Reference Books:

- 1) Simon Rogers, Mark Girolami, “A First Course in Machine Learning”, second edition, CRC Press, 2017.
- 2) Richard E. Neapolitan & Xia Jiang, “Artificial Intelligence with an introduction to machine learning”, second edition, CRC press, 2018.
- 3) Ethem Alpaydin, “Introduction to Machine Learning”, Prentice Hall of India, Third edition, 2014.
- 4) Mohssen Mohammed, Muhammad Badruddin Khan, Eihab Bashier Mohammed Bashier, “Machine Learning, Algorithms and Applications”, CRC Press, 2017.
- 5) Michael Paluszek, Stephanie Thomas, “MATLAB Machine Learning”, A press, 2017.

22PDEE151	IoT Applications	(4-0-0) 4
------------------	-------------------------	------------------

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on all the important design and implementation details of various functions possible with IoT such as use of specific sensors, computational devices and connectivity to the Internet.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Understand the vision of IoT from	-	6	5

	a global context.			
CO-2	Determine the market perspective of IoT	-	6	5
CO-3	Explore the devices, gateways and data management in IoT	-	4,6	-
CO-4	Build the state of art architecture in IoT	4	5,6	1
CO-5	Apply the concepts of IoT to solve industrial and commercial building automation and real world design constraints	4,5	1	2

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1.5	1	-	2.6	1.6	2

Pre-requisites: Fundamentals of computer network, wireless sensor network, communication & internet technology, web technology, information security.

Contents:

- 1) IoT & Web Technology:** The Internet of Things Today, time for convergence, towards the IoT universe, Internet of things vision, IoT strategic research and innovation directions, IoT applications, Future Internet technologies, Infrastructure, Networks and Communication, processes, Data management, Security, Privacy & Trust, device level Energy issues, IoT related standardization, Recommendations on research topics. **10 Hrs**
- 2) Machine to Machine(M2M) to IoT:** Basic perspective: Introduction, some definitions, M2M value chains, IoT value chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An architectural overview–building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. **09 Hrs**
- 3) IoT Architecture:** Introduction, State of the art, Architecture Reference Model-Introduction, Reference model and architecture, IoT reference Model, IoT reference architecture-Introduction, Functional view, Information view, Deployment and operational view, Other relevant architectural views. **09 Hrs**
- 4) IoT Applications for Value Creations:** Introduction, IoT applications for industry: Future factory concepts, Brownfield IoT, Smart objects, Smart applications, Four aspects in your business to master IoT, Value creation from big data and serialization, IoT for retailing industry, IoT for oil and gas industry,

Opinions on IoT application and value for industry, Home management, e-Health. **12 Hrs**

- 5) Internet of Things Privacy, Security and Governance:** Introduction, Overview of governance, Privacy and security issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-data-Platforms for smart cities, First steps towards a secure platform, Smart approach, Data aggregation for the IoT in smart cities security. **12 Hrs**

Reference Books:

- 1) Vijay Madiseti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", 1st Edition, VPT, 2015.
 - 2) Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, A press Publications, 2013.
 - 3) Cuno Pfister, "Getting Started with the Internet of Things," Reilly Media, 2011.
- Raj Kamal, "Internet of Things: architecture and design principles "McGraw Hill Education (India),2017.

22PDEE152	Nano Electronics	(4-0-0) 4
------------------	-------------------------	------------------

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on the study of various nanostructures, their properties and applications. The course also focuses on understanding the physical, chemical and fabrication aspects of nanostructures and nanodevices at nanoscale, relevant to the field of electronics.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Realize the significance of Nanoelectronics, as an emerging area in the field of electronics.	3	-	-
CO-2	Identify various nanostructures, discuss their properties and applications	-	4	-
CO-3	Analyze and discuss the physical effects occurring in various nanodevices.	4	-	5
CO-4	Classify different microscopic techniques required to study novel	-	4	-

	properties of nanostructures occurring at nanoscale.			
CO-5	Compare and differentiate various quantum structures, self assembly techniques.	-	-	1
CO-6	Discuss the applications of nanostructures, in relevance to the field of electronics.	3	5	6

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1	-	3	2.3	1	1

Pre-requisites:

Physics, Electronics, Engineering Mathematics, Material Science

Contents

- 1) **Introduction:** Overview of nanoscience and engineering, Development milestones in microfabrication and electronic industry. Moore’s law and continued miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale. Fabrication methods: Top down processes, Bottom up processes, methods describing the growth of nanomaterials, ordering of nanosystems. **10 Hrs**
- 2) **Characterization:** Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques.
Inorganic semiconductor nanostructures: Overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states. **12 Hrs**
- 3) **Fabrication techniques:** Requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching. Strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, colloidal quantum dots, self-assembly techniques.
Physical processes: Modulation doping, quantum hall effect, resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intraband absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing,

characterization of semiconductor nanostructures: optical electrical and structural. **14 Hrs**

4) Carbon Nanostructures: Carbon molecules, Carbon Clusters, Carbon Nanotubes, application of Carbon Nanotubes. **06 Hrs**

5) Nanosensors: Introduction, What is Sensor and Nanosensors?, What makes them Possible?, Order From Chaos, Characterization, Perception, Nanosensors Based On Quantum Size Effects, Electrochemical Sensors, Sensors Based On Physical Properties, Nanobiosensors, Smart dust Sensor for the future.

Applications: Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures. **10 Hrs**

Reference Books:

- 1) Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, “Nanoscale Science and Technology”, John Wiley, 2007.
- 2) Charles P Poole, Jr, Frank J Owens, “Introduction to Nanotechnology” , John Wiley, Copyright 2006, Reprint 2011.
- 3) T Pradeep, “Nano: The essentials-Understanding Nanoscience and Nanotechnology”, TMH.
- 4) Ed William A Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J lafrate, “ Hand Book of Nanoscience Engineering and Technology”, CRC press, 2003.

22PDEL101 Digital Circuits Simulation Laboratory (0-0-3) 2

Contact Hours: 30

Course Learning Objectives (CLOs):

The course focuses on design of digital circuits and verifying the same by using LabVIEW and Verilog code. The experiments are meant to give a good understanding of tools for realization of digital systems.

Course Outcomes (COs):

Description of the course outcomes: At the end of the course the students will be able to:		Mapping to POs (1-6)		
		Level 3 Substantial	Level 2 Moderate	Level 1 Slight
CO-1	Demonstrate logic gate implementation using LabVIEW /Verilog code.	-	4	-

CO-2	Design different digital circuits and verify the functional simulation by using Graphical programming tool LabVIEW.	3	5	-
CO-3	Design a digital system for addition and multiplication.	3	-	-
CO-4	Implement sequential digital circuits on FPGA board.	3	4	-
CO-5	Develop LIFO and FIFO systems.	3	4	-
CO-6	Build and Implement application based digital system as a part of Hobby Projects.	3,4	1,2,5	6

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2	2	3	2.25	2	1

Prerequisites: Digital Electronics, Verilog HDL

Contents:

PART A

Graphical Programming for digital circuits using LabVIEW

- 1) Design of Binary Subtractors
- 2) Design of Encoder (8 x 3), Decoder(3 x 8)
- 3) Design of Multiplexer (8 x 1) and Demultiplexer (1 x 8)
- 4) Design of FF (SR, D, T, JK, and Master Slave with delays)
- 5) Design of registers using latches and flip-flops
- 6) Design of 8-bit Shift registers

Part B

FPGA DIGITAL DESIGN

Download the programs on FPGA/CPLD boards and performance testing may be done using pattern Chip scope pro apart from verification by simulation with any of the frontend tool.

- 1) Write Verilog code for the design of 8-bit.
 - i. Carry Ripple Adder
 - ii. Carry Look Ahead adder
 - iii. Carry Skip Adder
- 2) Write Verilog Code for 8-bit
 - i. Array Multiplication
 - ii. Booth Multiplication (Radix-4)

- 3) Write Verilog code for 4/8-bit
 - i. Magnitude Comparator
 - ii. LFSR
- 4) Write Verilog Code for 3-bit Arbitrary Counter to generate 0,1,2,3,6,5,7 and repeats.
- 5) Design a Mealy and Moore Sequence Detector using Verilog to detect Sequence. Eg11101 (with and without overlap) any sequence can be specified.
- 6) Design a FIFO and LIFO buffers in Verilog and Verify its Operation.

Reference books:

- 1) Peter J. Ashenden, “Digital Design: An Embedded Systems Approach Using Verilog”, Elsevier, 2010.
- 2) Charles H. Roth, “Fundamentals of logic design”, Thomson Learning, 2004.
- 3) NCLaunch User Guide Product Version 3.1 June 2000.
- 4) NC Verilog Simulator Help Product Version 3.1 June 2000.

22PDEL102

Seminar

(0-0-2) 1

Contact Hours: 24

Course Learning Objectives(CLOs):

Seminar is to train students towards independent learning, review of technical papers, demonstrate sound knowledge of the selected topic, preparing the report and presentation of the same.

Course Outcomes(COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs (1 to 6)		
		Level 3 Substantial	Level 2 Moderate	Level 1 Slight
CO-1	Identify technically relevant and innovative topic from refereed technical journals/conferences	1	3	-
CO-2	Understand and analyze the selected topic.	-	1,4,5	-
CO-3	Compare different techniques relevant to the selected topic.	-	3	-
CO-4	Organize the topic in a systematic manner and prepare the report in a specific format	2	6	-
CO-5	Present the work in a systematic way.	2	6	-

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping levels	2.5	3	2	2	2	2

Contents:

- 1) The students are expected to select the topic of interest from refereed technical journals/conferences, carryout the literature survey for the selected topic and analyze the same.
- 2) The students are expected to document the work done in a systematic way and learn/improve the presentation skills.

Reference Material:

- 1) Reputed Journals
- 2) Engineering books
- 3) Software tools

II semester

22PDEC200

Digital VLSI Design

(4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on understanding the construction details and electrical characteristics of MOSFETs, designing different digital applications of MOSFETs for the high speed and low power considerations.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Explain the theory, construction and the characteristics of MOS structures.	-	-	5
CO-2	Design of an Inverter with different loads.	-	4,5	-
CO-3	Design digital circuits using various design styles.	4,5	-	6
CO-4	Discuss Bi-CMOS gates and Compare the performance of CMOS and Bi-CMOS logic circuits.	4,5	6	-
CO-5	Explore various memory structures and low power design techniques.	-	4,5	-
CO-6	Design and Validate performance of digital systems.	4,5	1,3,6	1

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2	1	2	2.6	2.6	1.6

Pre-requisites: Digital Circuit Design, Basic VLSI Design

Contents:

1) MOS Field Effect Transistors (MOSFETs): Device structure and physical operation, Current voltage characteristics, MOSFET circuits as DC, MOSFET as an amplifier and switch, Biasing in MOS Amplifier circuits. **08 Hrs**

- 2) **MOS Inverters:** Static Characteristics: Introduction, Resistive-Load Inverter, Inverters with n-Type MOSFET Load, CMOS Inverter. MOS Inverters: Switching Characteristics and Interconnect Effects: Introduction, Delay-Time Definition, Calculation of Delay Times, Inverter Design with Delay Constraints. **08 Hrs**
- 3) **Dynamic Logic Circuits:** Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High Performance Dynamic CMOS Circuits. **06 Hrs**
- 4) **Semiconductor Memories:** Introduction, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM), Non-volatile Memory, Flash Memory, Ferroelectric Random Access Memory (FRAM). **08 Hrs**
- 5) **Low-Power CMOS Logic Circuits:** Introduction, Overview of Power Consumption, Low-Power Design Through Voltage Scaling, Estimation and Optimization of Switching Activity, Reduction of Switched Capacitance, Adiabatic Logic Circuits. **08 Hrs**
- 6) **Bi-CMOS Logic Circuits:** Introduction, Bipolar Junction Transistor (BJT): Structure and Operation, Dynamic Behaviour of BJTs, Basic Bi-CMOS Circuits: Static Behaviour, Switching Delay in Bi-CMOS Logic Circuits, Bi-CMOS Applications. **08 Hrs**
- 7) **Chip Input and Output (I/O) Circuits:** Introduction, ESD Protection, Input Circuits, Output Circuits and $L(di/dt)$ Noise, On-Chip Clock Generation and Distribution, Latch-Up and Its Prevention. **06 Hrs**

Activity beyond syllabus: Design of Digital Circuits using Cadence Software.

Reference Books:

- 1) Sung Mo Kang & Yosuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design", Tata McGraw-Hill, Third Edition, 2003.
- 2) Neil Weste and K. Eshragian, "Principles of CMOS VLSI Design: A System Perspective", Second Edition, Pearson Education (Asia) Pvt. Ltd. 2000.
- 3) Jan M. Rabaey, Massoud Pedram, "Low Power Design Methodologies" Kluwer Academic, 2010.
- 4) ADEL Sedra, Kenneth C Smith, "Microelectronic Circuits Theory & Applications," Oxford Publication, 2013.

22PDEC201

Embedded System Design

(4-0-0) 4

Contact hours: 52

Course Learning Objectives (CLOs):

The course focuses on real time task scheduling, modifications required in multiprocessor environment, handling of resource sharing and database requirements.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Identify the principles and Characteristics of various applications of basic and Advanced Embedded systems.	3	-	1
CO-2	Realize different EDA tools and Embedded Firmware Design.	-	3,4	2
CO-3	Program 32-bit ARM Micro controller.	1	-	-
CO-4	Explain task, thread, process and various scheduling techniques.	-	4	5
CO-5	Distinguish between Dis-assembler or Decompiler, Simulator, Emulators and Debugging	-	5	-

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2	1	2.5	2	1.5	-

Pre-requisites: Operating systems

Contents:

1) Typical Embedded System: Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface. **08 Hrs**

2) Embedded Hardware Design and Development: EDA Tools, How to Use EDA Tool, Schematic Design – Place wire, Bus , port, junction, creating part numbers, Design Rules check, Bill of materials, Net list creation, PCB Layout Design Building blocks, Component placement, PCB track routing.

Embedded Firmware Design and Development: Embedded Firmware Design Approaches Embedded Firmware Development Languages. **14 Hrs**

3) ARM-32 bit Microcontroller family: Architecture of ARM Cortex-M3, General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Register, Nested Vector Interrupt Controller. Interrupt behavior of ARM Cortex M3. Exceptions Programming. Advanced Programming Features, Memory Protection. Debug Architecture. **12 Hrs**

4) Real-Time Operating System (RTOS) based Embedded System Design: Operating System Basics, Types of OS, Comparison of different RTOS, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling: Putting themal together, Task Communication, Task Synchronization. **10 Hrs**

5) The Embedded System Development Environment: The Integrated Development Environment (IDE), Types of Files Generated on Cross compilation, Disassembler/Decompiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan. **08 Hrs**

Activity beyond Syllabus:

Case study and Implementation of RTES.

Reference Books:

- 1) Shibu K. V., "Introduction to Embedded Systems", Tata McGraw Hill Education Pvt. Ltd.,2009.
- 2) Joseph Yiu, "The Definitive Guide to the ARM Cortex-M3", Newnes, (Elsevier),2008.
- 3) James K Peckol, "Embedded Systems – A contemporary Design Tool", John Weily, 2008.
- 4) Rajkamal "Embedded Systems architecture, programming and Design" Tata McGraw-Hill Education, second edition,2011.

22PDEE250

Parallel Computing

(3-0-0) 3

Contact hours: 39

Course Learning Objectives (CLOs):

The course focuses on basic parallel architectures and parallel algorithm design. The Message-Passing Programming (MPI) is introduced to provide an insight into various built-in functions. The shared memory programming deals with parallelization of simple looping techniques.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Identify the need for concurrency and parallel computing.	-	3	-
CO-2	Realize different parallel architectures based on instructions set architecture	-	3	-
CO-3	Explore the various techniques for shared memory programming.	-	4	5
CO-4	Explain the message passing model and explore the built-in functions of message passing interface	-	4	-
CO-5	Design parallel algorithms	-	4,6	5

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	-	-	2	2	1	2

Pre-requisites: Operating systems

Contents:

- 1) **Overview of Parallel Computing:** Evolution of Supercomputing, Modern Parallel Computers, Concurrency, Data Clustering, Programming Parallel Computers. **05 Hrs**
- 2) **Parallel Architectures:** Introduction, Interconnection Network, Processor Arrays, Multiprocessors, Centralized/ Distributed Multiprocessors, Multicomputer, Flynn's Taxonomy SISD, SIMD, MISD, MIMD. **08 Hrs**
- 3) **Shared Memory Programming:** Introduction, The shared memory model, Parallel for Loops, Declaring Private Variables, Critical Sections, Reductions, Performance Improvements, More General Data Parallelism, Functional Parallelism. **08 Hrs**
- 4) **Message Passing Programming:** Introduction, The Message-Passing Model, The Message-Passing Interface, Circuit Satisfiability, Introduction to Collective Communication, Function MPI_Reduce, Benchmarking Parallel Performance, Functions MPI_Wtime and MPI_Wtick, Function MPI_Barrier. **09 Hrs**
- 5) **Parallel Algorithm Design:** Introduction, The task/Channel Model, Foster's Design Methodology, Partitioning, Communication, Agglomeration, Mapping,

Boundary Value Problem, Finding the maximum, The n-Body Problem, Adding Data Input. **09 Hrs**

Activity beyond Syllabus:

Case study on different parallel algorithms.

Reference Books:

- 1) Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw Hill Education (India) Edition 2003.
- 2) Peter Pacheco, "An Introduction to Parallel Programming", Morgan Kaufmann Publishers, an imprint of Elsevier 2011.
- 3) Shameem Akhter, Jason Roberts, "Multi-Core Programming", Intel Press, 2006.
- 4) Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, "Introduction to Parallel Computing", Addison Wesley, 2003

22PDEE251 Low Power Circuits & Systems (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The course focuses on basics and advanced techniques in the low power design. Describe the various power reduction and the power estimation methods and also explain power dissipation at all layers of design hierarchy. Apply State-of-the art approaches to power estimation and reduction. Practice the low power techniques using current generation design style and process technology.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Identify the sources of power dissipation in CMOS circuits.	-	4	-
CO-2	Perform power analysis using simulation based and probabilistic approaches.	-	3	4
CO-3	Use optimization and trade-off techniques to reduce power dissipation of the digital circuits.	4	5	6
CO-4	Apply practical low power design techniques and their analysis at various levels of design abstraction in the latest design automation	4	5	6

	environments.			
CO-5	Build power efficient systems using advanced techniques.	6	4,5	1

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1	-	2	2.2	2	1.6

Pre-requisites: Digital VLSI Design

Contents:

- 1) **Introduction:** Need for low power VLSI chips, charging and discharging capacitance, short circuit current in CMOS circuit, CMOS leakage current, static current, basic principles of low power design, low power figure of merits. **05 Hrs**
- 2) **Simulation power analysis:** SPICE circuit simulation, discrete transistor modeling and analysis, gate level logic simulation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation. **05 Hrs**
- 3) **Probabilistic power analysis:** Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy. **04 Hrs**
- 4) **Circuit:** Transistor and gate sizing, equivalent pin ordering, network restructuring and reorganization, special latches and flip flops, low power digital cell library, adjustable device threshold voltage. **04 Hrs**
- 5) **Logic:** Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic. **03 Hrs**
- 6) **Low power Clock Distribution:** Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network. **03 Hrs**
- 7) **Low power Architecture & Systems:** Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation. **03 Hrs**
- 8) **Low power arithmetic components:** Introduction, circuit design style, adders, multipliers, division. **03 Hrs**
- 9) **Low power memory design:** Introduction, sources and reductions of power dissipation in memory subsystem, sources of power dissipation in DRAM and SRAM. **03 Hrs**
- 10) **Algorithm & Architectural Level Methodologies:** Introduction, design flow, Algorithmic level analysis & optimization, Architectural level estimation & synthesis. **Advanced Techniques:** Adiabatic computation, pass transistor logic synthesis, Asynchronous circuits. **06 Hrs**

Reference Books:

- 1) Gary K. Yeap, "Practical Low Power Digital VLSI Design", Kluwer Academic, 1998.
- 2) Jan M.Rabaey, Massoud Pedram, "Low Power Design Methodologies" Kluwer Academic, 2010.
- 3) Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" Wiley, 2000.
- 4) A. P. Chandrasekaran and R.W. Brodersen, "Low power digital CMOS design", Kluwer Academic, 1995.
- 5) A. Bellamour and M. I. Elmasri, "Low power VLSI CMOS circuit design", Kluwer Academic, 1995.

22PDEE252**Data Compression****(3-0-0) 3****Contact Hours: 39****Course Learning Objectives (CLOs):**

The course focuses on the need for compression, various lossless and lossy compression techniques and their performance measures. Some of the standards recommended for speech and video coding are also explained.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Describe various compression techniques and Understand the principles of different types of quantization	-	4	-
CO-2	Analyze various differential encoding methods	-	4	-
CO-3	Analyze various transform coding methods	4	3,5	-
CO-4	Apply analysis/synthesis schemes for speech compression.	4	1,5	-
CO-5	Understand various speech, image and video compression standards.	-	1,5	-
CO-6	Design and compare various lossless coding methods.	4	1,5	-

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2	-	2	2.6	2	-

Pre-requisites: Digital Signal Processing, Digital Communication, Information Theory and Coding.

Contents:

- 1) Introduction:** Compression techniques, Modeling & coding, Distortion criteria. **03 Hrs**
- 2) Quantization:** Quantization problem, Uniform Quantizer, Adaptive Quantization, Non-uniform Quantization; Entropy coded Quantization, Vector Quantization, LBG algorithm, Tree structured VQ, Structured VQ, Variations of VQ – Gain shape VQ, Mean removed VQ, Classified VQ, Trellis coded quantization. **06 Hrs**
- 3) Differential Encoding:** Basic algorithm, Prediction in DPCM, Adaptive DPCM, Delta Modulation. **05 Hrs**
- 4) Transform Coding:** Transforms – KLT, DCT, DST, DWHT; Quantization and coding of transform coefficients, Application to Image compression – JPEG, Application to audio compression. **04 Hrs**
- 5) Analysis/Synthesis Schemes:** Speech compression – LPC-10, CELP, MELP, Image Compression – Fractal compression. **05 Hrs**
- 6) Video Compression:** Motion compensation, Video signal representation, Algorithms for video conferencing & videophones – H.261, H. 263, Asymmetric applications – MPEG 1, MPEG 2, MPEG 4, MPEG 7, Packet video. **06 Hrs**
- 7) Lossless Coding:** Huffman coding, Adaptive Huffman coding, Golomb codes, Rice codes, Tunstall codes, Applications of Huffman coding, Arithmetic coding, Dictionary techniques – LZ77, LZ78, Applications of LZ78 – JBIG, JBIG2, Predictive coding – Prediction with partial match, Burrows Wheeler Transform, Applications – CALIC, JPEG-LS. **10 Hrs**

Reference Books:

- 1)** K. Sayood, "Introduction to Data Compression," Harcourt India Pvt. Ltd. & Morgan Kaufmann Publishers, 1996.
- 2)** N. Jayant and P. Noll, "Digital Coding of Waveforms: Principles and Applications to Speech and Video," Prentice Hall, USA, 1984.
- 3)** D. Salomon, "Data Compression: The Complete Reference", Springer, 2000.
- 4)** Z. Li and M.S. Drew, "Fundamentals of Multimedia," Pearson Education (Asia) Pvt. Ltd., 2004.

22PDEE253 Artificial Neural Networks & Deep Learning (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

This course offers an introduction to Artificial Neural Networks and Deep Learning. The course deals with selected topics of deep Learning, discussing recent models from both supervised and unsupervised learning. Special emphasis will be on convolutional architectures, invariance learning, back propagation and non-convex optimization. Also course covers models for various applications, how they are trained, validated and deployed in the wild.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to PO (1 to 6)		
		Level 3 Substantial	Level 2 Moderate	Level 1 Slight
CO-1	Realize the role of neural networks in engineering, artificial intelligence and learn basic neural network architecture.	-	6	2
CO-2	Implement Perception learning algorithm and Adaptive linear combiner.	-	3	1
CO-3	Develop delta learning rule of the output layer and Multilayer feed forward neural network with continuous perceptions.	3	4	1
CO-4	Calculate weight gradients in a feed forward neural network using back propagation algorithm.	3	4	2
CO-5	Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.	-	6	2,1

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1.0	1.0	2.7	2.0	---	2.0

Pre-requisites: Linear Algebra, Probability & Statistics

Contents:

- 1) Introduction:** Neural Network, The human brain, Models of a neuron, Neural networks viewed as directed graphs, Feedback, Network architectures, Knowledge representation **02 Hrs**
- 2) Single layer Perception:** Introduction, Pattern Recognition, Linear classifier, Simple perception, Perception learning algorithm, Modified Perception learning algorithm, Adaptive linear combiner, Continuous perception, Learning in continuous perception. Limitation of Perception. **04 Hrs**
- 3) Multi-Layer Perceptron Networks:** Introduction, MLP with 2 hidden layers, Simple layer of a MLP, Delta learning rule of the output layer, Multilayer feed forward neural network with continuous perceptions, Generalized delta learning rule. **06 Hrs**
- 4) Activation Functions, Gradient descent & Back propagation:** Sigmoid, ReLU, Hyperbolic Fns, Softmax, Gradient descent, Stochastic gradient descent, back propagation, Some problems with ANNs. **02 Hrs**
- 5) Optimization & Regularization:** Overfitting and Capacity, Cross validation, Feature selection, Regularization & Hyperparameters. **05 Hrs**
- 6) Introduction to Convolutional & Recurrent Neural Network:** Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple filters, CNN applications, Introduction to RNNs, unfolded RNNs, Seq2seq RNNs, LSTM, RRN applications. **08 Hrs**
- 7) Deep Unsupervised Learning:** Encoder Decoder architecture, Auto-encoders (standard, sparse, denoising, contractive), Variational auto encoders, Adversarial generative networks, DBM. **06 Hrs**
- 8) Applications of Deep Learning to NLP:** Introduction to NLP and vector space model semantics, Word vector representations: Continuous Skip-Gram model, Continuous of words model, Glove, Evaluations and applications in word similarity, analogy reasoning. **06 Hrs**

Activity beyond Syllabus: Seminar, Simulation based project.

Reference Books:

- 1) Simon Haykin, "Neural networks and Learning machines", 3/e, Pearson education, 2009.
- 2) Zurada and Jacek M, "Introduction to Artificial Neural Systems", West Publishing Company, 1992.
- 3) Goodfellow, I., Bengio, Y, and Courville A., "Deep learning", MIT press, 2016.
- 4) Bishop C.M., "Pattern Recognition & Machine learning", Springer, 2006.
- 5) Yegnanarayana, B., Artificial Neural Networks, PHI Learning Pvt Ltd 2009.

22PDEE254

Cryptography

(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The course focuses on techniques of enciphering and deciphering messages to maintain privacy of confidential data. It also discusses algorithms for authentication and integrity.

Course Outcomes (COs):

Description of Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Analyze and Apply different symmetric cryptographic techniques to encrypt and decrypt data.	-	4,5	1,3
CO-2	Describe basic mathematical concepts and pseudorandom number generators required for cryptography.	4	-	3
CO-3	Apply and estimate different asymmetric cryptographic algorithms.	5	1	6
CO-4	Explain authentication functions to authenticate and protect the encrypted data.	5	-	6
CO-5	Analyze key exchange algorithms.	-	1	3
CO-6	Discuss algorithms for digital signature schemes.	-	4,5	1

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2.5	-	1	2.33	2.5	1

Pre-requisites: Communication networks and finite fields

Contents:

- 1) Symmetric Block Ciphers:** Terminology, Traditional Block Cipher structure, Data encryption standard (DES), Double DES, 3DES, The AES Cipher. **Number Theory:** Introduction to modular arithmetic, Prime Numbers, Fermat's and Euler's theorem, primality testing, Discrete logarithms. **11 Hrs**
- 2) Public-Key Cryptosystems:** Principles, The RSA algorithm, Diffie- Hellman Key Exchange, Elgamal cryptographic system, Elliptic Curve Arithmetic, Elliptic Curve Cryptography. **09 Hrs**
- 3) Pseudo-Random-Sequence Generators and Stream Ciphers:** Linear Congruential Generators, Linear Feedback Shift Registers, Design and analysis of stream ciphers, Stream ciphers using LFSRs, A5, Hughes XPD/KPD, Additive generators, GIFFORD, Algorithm M. **07 Hrs**
- 4) One-Way Hash Functions:** Background, SNEFRU, N-Hash, MD5, Secure Hash Algorithm [SHA], Message Authentication Codes. **06 Hrs**
- 5) Digital Signatures:** Digital signatures, Elgamal Digital Signature Scheme, Digital signature Algorithm, RSA digital signatures, Elliptic Curve DSA. **06 Hrs**

Reference Books:

- 1) William Stallings, "Cryptography and Network Security Principles and Practice", Pearson Education Inc., 6th Edition, 2014, ISBN:978-93-325-1877-3.
- 2) Bruce Schneier, "Applied Cryptography Protocols, Algorithms, and Source code in C", Wiley Publications, 2nd Edition, ISBN: 9971-51-348-X.
- 3) Behrouz A. Forouzan, "Cryptography and Network Security", 2nd Edition, TMH, 2007.
- 4) Atul Kahate, "Cryptography and Network Security", 3rd Edition, TMH, 2013.

22PDEE255	Wireless Communication Networks	(3-0-0) 3
------------------	--	------------------

Contact Hours: 39

Course Learning Objectives (CLOs):

The course focuses on evolution of cellular technologies from 1G to 5G, their architecture and advantages / applications. It deals with cellular structure, capacity expansion methods, modulation, multiplexing techniques and hardware architecture with respect to various cellular technologies. This course also deals with LTE, 4G technology and brief overview of upcoming 5G technology.

Course Outcome (COs):

Description of the Outcome - Upon completion of the course, the student will be able to:		Mapping to POs (1-12) / PSOs (13,14)		
		Level 3 Substantial	Level 2 Moderate	Level 1 Slight
CO-1	Discuss the evolution and history of wireless technology and compare different mobile Networks along with their common system components	-	1,3,4	2,5,6
CO-2	Apply the cellular concepts such as frequency reuse, handoff to evaluate the signal reception and performance of cellular systems	-	1,3,4	2,5,6
CO-3	Explain GSM, TDMA, CDMA network components, network interfaces and protocols, channel concept and call establishment operations	-	1,3,4	2,5,6
CO-4	Discuss LTE cellular technology, architecture and features in detail	-	1,3,4	2,5,6
CO-5	Explain 4G and 5G requirements, regulations, spectrum analysis and sharing for 5G spectrum.	-	1,3,4	2,5,6

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2	1	2	2	1	1

Pre-requisites: Communication Systems

Contents:

- 1) Introduction to Wireless Communication:** Evolution, different generations of wireless cellular networks, 1G, 2G, 3G and 4G cellular systems and beyond, **Common Cellular System Components:** Common cellular network components, hardware and software views of the cellular networks, 3G cellular systems components, cellular component identification, call establishment.

06 Hrs

- 2) Common Wireless Network Architecture and Operation:** The cellular concept, cell fundamentals, capacity expansion techniques, cellular backhaul networks mobility management, radio resources and power management, wireless network security. **05 Hrs**
- 3) GSM and TDMA Technology:** GSM system overview - Introduction to GSM and TDMA, GSM network and system architecture, GSM channel concept, GSM system operations - GSM identities, GSM system operations (traffic cases), GSM infrastructure communications, Other TDMA systems – north American TDMA, **CDMA Technology:** CDMA system overview-Introduction to CDMA, CDMA channel concept, CDMA operations. 3G CDMA – IS-95-B, cdma2000, W-CDMA. **06 Hrs**
- 4) Cellular Wireless Data Networks – 2.5G, 3G systems:** Introduction to mobile wireless data networks, CDPD, GPRS, and EDGE data networks, CDMA data networks, evolution of GSM and NA-TDMA to 3G, evolution of CDMA to 3G, SMS, EMS, MMS, MIM services. **05 Hrs**
- 5) Wireless Modulation Techniques and Hardware:** Transmission characteristics of wireline and fiber systems, characteristics of air interface, wireless coding techniques, digital modulation techniques, spread spectrum modulation techniques, UWB radio technology, diversity techniques, typical GSM system hardware, typical CDMA system hardware. **05 Hrs**
- 6) Key enabling Technologies and Features of LTE:** Demand drivers for LTE, Key requirements of LTE design, Key enabling Technologies and features of LTE, LTE Network architecture, Spectrum options and migration plans of LTE, Future of mobile broadband-beyond LTE. **06 Hrs**
- 7) 4G LTE Cellular Technology:** Introduction, fourth generation mobile communication, Need and scope for 4G technology, Network architecture of 4G, Geographical Coverage of 4G, features of 4G technology, **5G Broadband Wireless Communications:** An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G, features of 5G technology. **06 Hrs**

Activity beyond Syllabus:

Seminar on related latest technology

Reference Books:

- 1) Mullet, “Wireless Telecommunication Systems and networks”, Thomson Learning 2006.
- 2) D. P. Agrawal, “Wireless communication”, 2/e, Thomson Learning, 2007.
- 3) Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed, Fundamentals of LTE, Prentice Hall, Communications Engineering and Emerging Technologies.
- 4) Farooq Khan, “LTE for 4G Mobile Broadband: Air Interface Technologies and Performance”, Cambridge University Press, 2009.

22PDEE256 Micro Electro Mechanical Systems (3-0-0) 3

Contact Hours:39

Course Learning Objectives (CLOs):

The course focuses on the study of various electromechanical sensors, actuators and their transduction principles at micro and nanoscale. The course covers the advanced domains of electronics, material science and mechanics at research level.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substanti al Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Understand and appreciate the significance of MEMS, as an emerging area in the field of electronics.	-	3	6
CO-2	Identify various micro sensors and actuators being used for electromechanical applications.	4	-	-
CO-3	Discuss the processes involved in the fabrication of different micro sensors and micro actuators.	4	-	-
CO-4	Design simple micro sensors and actuators using CAD softwares and perform simulations.	-	-	1

CO-5	Classify various micro system packaging technologies related to MEMS.	-	5	-
CO-6	Apply processing steps, scaling laws and transduction principles towards the realization of MEMS product design.	4	5	-

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1	-	2	3	2	1

Pre-requisites: Physics, Electronics, Engineering Mathematics, Material Science, Basic Mechanical principles

Contents:

- 1) **Overview of MEMS & Microsystems:** MEMS & Microsystems, Typical MEMS and Micro system products — features of MEMS, The multi disciplinary nature of Applications of Microsystems.
Scaling Laws in Miniaturization: Introduction to scaling, scaling in geometry, scaling in rigid body dynamics, scaling electrostatic forces, electromagnetic forces and electricity. **08 Hrs**
- 2) **Transduction Principles in MEMS & Microsystems:** Electro-mechanical Transducers: Piezoelectric, Electrostrictive, Magnetostrictive transducers, Electrostatic, Electromagnetic, Electrothermal actuators.
Microsensing for MEMS: Piezoresistive, Capacitive, Piezoelectric, Resonant, SAW sensors, Bio-MEMS and Biosensors. Micro-accelerometers, Micro-gyroscopes. **10 Hrs**
- 3) **MEMS materials and Fabrication Techniques:** Materials used for MEMS, Photolithography, Ion-implantation, diffusion, oxidation, CVD, PVD, etching techniques. Some MEMS fabrication processes: Surface micro-machining, Bulk micromachining, LIGA process. **08 Hrs**
- 4) **Micro System Design and Modeling:** Introduction, Design considerations: Process design, Mechanical design, Modeling using CAD tools: Multiphysics or Intellisuite or MEMS CAD, Features and Design considerations of RF MEMS, MEMS switches, MEMS inductors and capacitors, Design and Modeling: case studies - i) Cantilever beam ii) Micro switches. **08 Hrs**
- 5) **Micro system packaging:** Over view of mechanical packaging of micro electronics micro system packaging, Interfaces in micro system packaging, Packaging technologies. **05 Hrs**

Reference Books:

- 1) Tai Ran Hsu, “MEMS and Micro Systems: Design and Manufacture”, Tata McGraw Hill, 2002.
- 2) V.K.Varadan, K.J.Vinoy, K.A.Jose, “RF MEMS and their Applications”, Wiley-India, 2011.
- 3) Boca Raton, “MEMS and NEMS: Systems, Devices and Structures”, CRC Press, 2002.
- 4) J. W. Gardner and V. K. Vardan, “Micro Sensors MEMS and SMART Devices”, John Wiley, 2002 N. Maluf, “Introduction to Micro Mechanical Systems Engineering, Artech House”, Norwood, MA, 2000.

22PDEL201 VLSI and Embedded Systems Laboratory (0-0-3) 2

Contact Hours: 30

Course Learning Objectives (CLOs):

The course focuses on the design and implementation of various Digital circuits using Cadence software and different applications of embedded systems using NXP LPC1768.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1 to 6)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Design, Implement and characterize Combinational Circuits.	-	3	4,5
CO-2	Design, Implement and characterize Sequential circuits.	3,5	4	6
CO-3	Demonstrate programming skills using Assembly Level Language and High-Level Language such as C	-	4	3
CO-4	Explore Interrupt Service Routine (ISR) for various sources of interrupts.	-	4,5	6
CO-5	Demonstrate the usage and importance of Inter Process Communication(IPC)	3	4,5	6

POs	PO1	PO2	PO3	PO4	PO5	PO6
------------	------------	------------	------------	------------	------------	------------

Mapping Level	-	-	2.25	1.8	2	1
----------------------	---	---	------	-----	---	---

Contents:

Part A

Draw the Schematic and Layout for the following digital and analog circuits mentioned below with the help of Cadence tool frame work and verify the following.

- a. Schematic: i) DC Analysis ii) Transient Analysis iii) Parametric analysis
- b. Layout: i) DRC ii) LVS iii) RCX
- 1) Design CMOS Inverter with given specifications.
- 2) Design 2-bit full adder using half adders (Half adder has to be designed using Transmission Gates.
- 3) Design 4 bit UP/Down counter.

Part B

Implement the following experiments on ARM Cortex-M3.

- 1) Write an Assembly language program to calculate $10+9+8+\dots+1$
- 2) Write an Assembly language program to link multiple object files and link them together.
- 3) Write an Assembly language program to store data in RAM.
- 4) Write C program to output "Hello World" message using UART.
- 5) Write C program to design a stopwatch using interrupts.

Reference books:

- 1) Sung Mo Kang & Yusuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design", 3/e, McGraw-Hill, 2008.
- 2) Donald D Givone, "Digital Principles and Design". Tata McGraw Hill Edn, 2003.
- 3) Charles H. Roth, "Fundamentals of logic design", Thomson Learning, 2004.
- 4) Joseph Yiu, "The Definitive Guide to ARM Cortex-M3", Newnes Publication.

22PDEL202

Seminar

(0-0-2) 1

Contact Hours: 24

Course Learning Objectives(CLOs):

Students are provided with a platform for studying technical papers, analyze the references and compare different existing techniques found during the review of technical journals or conference proceedings. It also gives scope to perform case study or simulation of the assigned task.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs (1-6)		
		Level 3 Substantial	Level 2 Moderate	Level 1 Slight
CO-1	Explore the reputed journal papers in the area of interest and identify technically relevant and innovative ideas.	1	6	-
CO-2	Understand the content of technical references and summarize the same.	1	3	-
CO-3	Compare different existing techniques found in the review, perform case study or simulate the assigned work.	-	3, 4, 6	5
CO-4	Organize the outcome of the work carried out in the form of a report	2	-	-
CO-5	Present the work in a systematic way imbibing professional ethics	2	3	-

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping levels	3	3	2	2	1	2

Contents:

- 1) Students are expected to select the topic of interest from refereed technical journals/conferences, carryout the literature survey for the selected topic and analyze the same.
- 2) Students are expected to document the work done in a systematic way and learn/improve the presentation skills.

Reference Material:

- 1) Reputed Journals
- 2) Engineering books
- 3) Software tools