UNIVERSITY OF DELHI

CNC-II/093/1/EC-1273/25/
Dated: 13.05.2025
20

NOTIFICATION

Sub: Amendment to Ordinance V
(ECR 38-22 dated 17.01.2025)

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

The following syllabi of Department of Electronic Science under the Faculty of Inter-disciplinary and Applied Sciences based on Undergraduate Curriculum Framework 2022, are notified herewith for the information of all concerned:

(i) BSc. (Hons.) Electronics – Semester-VII and VIII ***(Annexure-1)***
(ii) BSc. (Hons.) Instrumentation – Semester-VII and VIII ***(Annexure-2)***

REGISTRAR

Annexure-1

ELECTRONIC SCIENCE

CORE AND DSE COURSES OFFERED BY DEPARTMENT OF ELECTRONIC SCIENCE

VII Semester

Category I

Electronics Course for Undergraduate Programme of study with Electronics as a Single Core Discipline

(B.Sc. Honours in Electronics)

DISCIPLINE SPECIFIC CORE COURSE –19: Control Systems

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Control Systems	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	-

Learning Objectives

This course provides the fundamental understanding of Mathematical modeling and analysis of open loop and closed loop control systems in terms of electrical equivalent circuits. Student should be in position to explain the nature of stability of systems using different criteria and plots. They should be able to identify the Controllability and Observability of a system to explore its applications.

Learning outcomes

After successful completion of this course, student will be able to

- Analyze the concepts of open and closed loop control systems
- Develop the mathematical model of a physical system
- Analyze the stability of control systems with the help of different criteria and plots.
- Identify the needs of different type of controllers.
- Analyze controllability and Observability by state space models.

SYLLABUS OF ELDSC-19 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Introduction to classification of systems: Linear and Nonlinear systems, Time invariant and Time varying system, Continuous time and Discrete time system, Dynamic and Static system, SISO and MIMO, Open loop and Closed loop control systems, Transfer functions, Mathematical modelling of Physical systems (Electrical, Mechanical and Thermal), D.C. motors and A.C. servomotors, block diagram representation & signal flow graph, Mason's Gain Formula, Effect of feedback on parameter variations

UNIT – II (12 Hours)

Test input signals for transient Analysis, transient response of first , second and higher order system for different test input signals , Time domain performance parameters of second order System , Steady state errors and Static error constants

Concept of Stability: Effect of location of poles on stability, Asymptotic stability and Conditional stability, Routh – Hurwitz criterion, Root Locus techniques and their applications. concept and applications of PI, PD and PID controllers .

UNIT – III (11 Hours)

Advantages of frequency domain analysis, Frequency domain specifications, Correlation between time and frequency response, Polar plot, Logarithmic plots (Bode Plots), Gain and Phase margins, Nyquist stability criterion.

UNIT – IV (11 Hours)

Definition of State, State variables and State models, State Space Representation of dynamic systems (Electrical networks and nth order differential equation), State Transition Matrix, Decomposition of Transfer Function, Controllability and Observability.

Compensation Techniques: Concept of compensation techniques Lag, Lead and Lag-Lead networks

Practical component (if any) – Control Systems Lab

(Hardware and Scilab/MATLAB/Other Mathematical Simulation software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Perform experiments involving concepts of control systems
- Design experiments for controlling devices like AC/DC motor etc.
- Study behavior of systems

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To study response of systems for various standard test input signals.
2. To study position and speed control of DC motor.
3. To find torque speed characteristics of AC servomotor.
4. To study time and frequency domain specifications of a control system.
5. To plot Bode, Root locus and Nyquist plots and determine stability.
6. To study the effect of PI, PD and PID controller on closed loop systems.
7. State space analysis for a given Transfer function

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than six.

Essential/recommended readings

1. J. Nagrath& M. Gopal, Control System Engineering, New Age International, 5th Edition, 2007
2. K. Ogata, Modern Control Engineering, Pearson, 5th Edition, 2010
3. B. C. Kuo and Farid Golnaraghi, Automatic control system, 9th Edition, Wiley, 2009

Suggestive readings

1. Joseph J Distefano, Allen R Stubberud, Ivan J Williams, - Control Systems, Schaum's Out lines, Tata McGraw Hill, third Edition, 2010

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

DISCIPLINE SPECIFIC ELECTIVES (DSE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Advanced Machine Learning ELDSE7A	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**-**

Learning Objectives

Machine Learning (ML) has emerged as one of the most dominant fields under AI, which has produced a significant impact in almost all the other sectors of science and technology including consumer electronics, robotics, Internet of Things and preventive health care to name a few. The primary focus of this course is to provide a comprehensive understanding of various advanced machine learning algorithms which can be used to design efficient automated systems and learning agents which are able to self-adapt and reprogram themselves according to their changing surroundings. These intelligent agents designed using ML algorithms have the ability to self-learn from the consequences of their past actions such that they can make improved decisions in the future.

Learning outcomes

After successful completion of this course, student will be able to

- CO1 Develop a good understanding of machine learning concepts
- CO2 Formulate a machine learning problem
- CO3 Develop a model using supervised and unsupervised machine learning algorithms for classification, regression and clustering
- CO4 Evaluate performance of various machine learning algorithms on various data sets of a chosen domain.

SYLLABUS OF ELDSE-7A Total Hours- Theory: 45 Hours, Practicals: 30 Hours

Unit I: (12 Hours)

A Brief overview of Machine Learning: Supervised Learning, Unsupervised Learning and Reinforcement Learning. Supervised Learning Vs. Unsupervised Learning. Classification Vs. Regression Analysis. Criteria for selecting training data and test data, concept of over-fitting and under fitting.

Supervised Learning : Regression Analysis in Supervised Learning- Linear Regression: Simple Linear Regression, Multiple Linear Regression, Polynomial Regression, Feature selection algorithms.

Classification algorithms in Supervised Learning - Linear models for classification, Logistic Regression, K-NN Algorithm, Decision Tree Classification Algorithm, Random Forest Algorithm, Support Vector Machine Classifier

Unit II : (11 Hours)

Unsupervised Learning: Clustering, K-Means Clustering Algorithm, Agglomerative Clustering, DBSCAN (density-based spatial clustering of applications with noise), Comparing and Evaluating Clustering Algorithms, Generating Association Rule, Principal Component Analysis (PCA), Non-Negative Matrix Factorization (NMF), Manifold Learning with t-SNE Clustering.

Unit III: (12 Hours)

Probabilistic Reasoning Models and Bayesian Learning:

Bayesian Networks- representation, construction and inference, Temporal model: concept of Transition probability. Naïve Bayes algorithm.

Markov Decision Process (MDP) Model: Simple Markov Model and Hidden Markov model, MDP formulation, utility theory, utility functions, value iteration, policy iteration and Q- Learning. Elements of MDP Model, Concept of Sequential Decision Processing, Example of MDP Problem: Agent in a grid world.

Reinforcement Learning: Passive Reinforcement learning and Active Reinforcement Learning.

Unit IV: (10 Hours)
Computational Learning Theory:
Probably Approximately Correct (PAC) learning model, Sample Complexity for finite hypothesis spaces, Sample Complexity for infinite hypothesis spaces, Mistake bound model of learning.
Instance Based Learning: Distance Weighted Nearest Neighbor algorithm.

Practical component (if any) – Advanced Machine Learning Lab
(Algorithms to be implemented in Python or any other suitable programming language)

Learning outcomes

At the end of this course, Students will be able to

CO1 Effectively use various machine learning tools
CO2 Understand and implement the procedures for machine learning algorithms
CO3 Design Python programs for various machine learning algorithms
CO4 Apply appropriate datasets to machine learning algorithms
CO5 Analyze the graphical outcomes of learning algorithms with specific datasets

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Perform Simple Linear Regression and Multiple Linear Regression.
2. Write a program to implement Logistic Regression.
3. Write a program to implement the following algorithms
    a. K-NN Classifier
    b. Decision Tree Classification Algorithm
    c. Support Vector Machine Classifier
4. Write a program to implement K-Means Clustering Algorithm
5. Write a program to demonstrate Agglomerative Hierarchical Clustering
6. Write a program for construction and inference of a Bayesian network
7. Write a program to implement Naïve Bayes classifier.
8. Write a program to implement Simple Markov and Hidden Markov Model
9. Write a program to demonstrate sequential decision processing in Markov Decision Process model by considering the problem of an agent in a grid world

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eight.

Essential/recommended readings

1. Introduction to Machine Learning with Python, by Andreas C. Müller, Sarah Guido, O'Reilly Media, Inc., 2016.
2. Machine Learning by Tom. M. Mitchell, Tata McGraw Hill, 1st ed (reprint) 2017.
3. Introduction to Machine Learning by Nils. J. Nilsson, 1998.
4. Introduction to Machine Learning by E. Alpaydin, PHI, 2005.

Suggestive readings

1. Machine Learning: A Probabilistic Perspective by Kevin P. Murphy, MIT Press, 2012.
2. Pattern recognition and Machine Learning by Christopher M. Bishop, Springer, 2006.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Neural Networks and Deep Learning ELDSE7B	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**-**

Learning Objectives

This course aims to develop a fundamental understanding of the basic principles behind deep learning and focuses on learning complex, hierarchical feature representation from raw data. The course applies and evaluates deep learning on standard data set and suggests examples of how deep learning can be used in different domains. This course must enable student to read and critically assess papers on deep learning and their applications, such as Image classification, Natural Language Processing.

Learning outcomes

On successful completion of this course, students will be able to

CO1 Describe the major differences between deep learning and other types of machine learning algorithms.

CO2 Differentiate between the major types of neural network architectures (multi-layered perceptrons, convolutional neural networks, recurrent neural networks, etc.) and what types of problems each is appropriate for.

CO3 Design neural network architectures for new data problems based on their requirements and problem characteristics and analyze their performance.

CO4 Describe some of the latest research being conducted in the field and open problems that are yet to be solved.

SYLLABUS OF ELDSE-7B **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

Unit I: (11 Hours)

Introduction to Deep Learning:

Definition of Deep Learning (as a subset to Machine Learning, Artificial Intelligence), Intuition and the need of Deep Neural Networks, structure of Artificial Neural Networks (ANNs) (input layer, hidden layer, output layer), need of Activation Functions, types of Activation Functions (Threshold function, Sigmoid function, ReLU function, Hyperbolic Tangent function). Softmax

Unit II : (12 Hours)

Neural Networks:

Idea of Perceptron, Multi-Layer Perceptron, Feed Forward Networks (FFNs), Backpropagation, Loss of functions, Gradient Descent.

Introduction to the types of Deep Neural Networks: Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Radial Based Networks, Deep Neural Networks, Long Short-Term Memory Networks (LSTMs), Learning/Training and optimisation algorithms for each type, Restrictive Boltzmann Machines (RBMs), Stacking RBMs, Belief Nets.

Unit III: (11 Hours)

Principal Component Analysis and Regularization:

Eigen values and Eigen vectors, Principal Component Analysis (PCA) and its interpretation, Singular Value Decomposition, Autoencoders and relation to PCA, Regularization in Autoencoders, Bias Variance Trade-off, L1 and L2 regularization, Dropout regularization, Early Stopping to prevent overfitting, Ensemble method.

Unit IV: (11 Hours)

Introduction to CNNs and Deep Learning Application:

Convolution, Filter (Kernels), Pooling, Deep CNNs, state of the art Deep CNN architectures – LeNet, AlexNet, VGG, ResNet, ShuffleNet. Weights initialization, Batch normalization, Hyperparameter optimization, Understanding and visualizing CNNs. Use of optimization methods for neural networks (AdaGrad, RMSProp, Adam), Second order methods for training.

Applications: Virtual Assistants, Chatbots, Image captioning, Self-Driving Cars, Natural Language Processing, Visual Recognition, Large Language Models (LLMs).

Practical component (if any) – Neural Network and Deep Learning Lab
(Python- using the Deep Learning Libraries)

Learning outcomes

At the end of this course, Students will be able to

CO1 Implement fundamental building blocks.
CO2 Apply their learning to real world scenarios.
CO3 Design NN architectures for new Data problems.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Write a program to predict Handwritten Digits using a Neural Network.
2. Write a program to predict whether the income of a person exceeds a certain amount per year based on specific criteria, using TensorFlow and any data set from a Machine Learning Repository
3. Write a program to analyze various aspects of an individual and predict what class of income he/she belongs to (example: >50k or <=50k) by using census data.
4. Write a program to classify images of cats and dogs using a neural network.
5. Write a program to predict the prices of stocks using the "Google stock price" data using LSTM.
6. For the dataset (California Housing Price/Pima Indians Diabetes), apply regularization techniques.
7. Apply PCA to reduce MNIST dimensions (visualizing eigenvalues/vectors), then train a neural network with L2/dropout regularization to explore bias-variance tradeoffs and prevent overfitting.
8. Fine-tune a pre-trained VGG19 model on Kaggle's Chest X-Ray dataset (5,863 images) to classify pneumonia vs normal cases, experimenting with batch normalization and learning rate decay while analyzing performance metrics.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than seven.

Essential/recommended readings

1. Deep Learning, An MIT Press book, Ian Goodfellow and Yoshua Bengio and Aaron Courville http://www.deeplearningbook.org

2. S. Haykin, Neural Networks and Learning Machines, Prentice Hall of India, 2010
3. B. Yegnanarayana, Artificial Neural Networks, Prentice- Hall of India, 1999

Suggestive readings

1. Satish Kumar, Neural Networks - A Classroom Approach, Second Edition, Tata McGraw-Hill, 2013
2. C.M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-3)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Digital Communication System ELDSE7C	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	-

Learning Objectives

The course introduces students to the fundamentals and key modules of digital communication systems with emphasis on digital modulation techniques and error and code detection. The basics of information theory, source coding techniques and entropy of source will also be covered.

Learning outcomes

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

- Understand the concept of digital communication system.
- Compare various digital modulation and demodulation techniques.
- Understand the effect of noise on system performances.
- Generate coding sequences for different error correcting codes.

SYLLABUS OF ELDSE-7C **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (12 Hours)
An overview of sampling theorem and multiplexing.
Random processes, stationary processes, mean, correlation, and covariance functions: autocorrelation function, cross-correlation function, Power spectral density.
Information Theory: Entropy, Information rate and channel capacity: Hartley's law, Shannon Hartley's theorem, Source coding: Huffman coding.

UNIT – II (12 Hours)
Digital base band transmission and Reception: line coding (Unipolar Return to Zero (RZ), Unipolar Non-Return to Zero (NRZ), Bipolar NRZ, split phase Manchester, differential coding) comparison in performance and Power spectra density. Probability of error, ISI, Matched filter, probability of error using matched filter.

UNIT – III (10 Hours)
Digital Modulation Schemes: ASK(Amplitude Shift Keying), FSK(Frequency Shift Keying), PSK(Phase Shift Keying), DPSK(Differential Phase Shift Keying), QPSK(Quadrature Phase Shift Keying), QAM(Quadrature Amplitude Modulation) and M-ary coding. Constellation diagram, transmitter and receiver block diagram.

UNIT – IV (11 Hours)
Channel/line coding: ASCII and EBCDIC binary codes, Error, Error detection and correction using parity, checksum, Vertical redundancy Check (VRC), Longitudinal Redundancy Check (LRC), Cyclic Redundancy Check (CRC), Linear block code, Hamming code.

Practical component (if any) – Digital Communication System Lab
(Hardware and/or software using MATLAB/SCILAB)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand sampling.
- Understand basic theories and generation and detection of Digital communication techniques.
- Simulate and use software for applications in communication electronics.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Study Sampling theorem using software.
2. Study of generation of Unipolar and bipolar RZ & NRZ Line coding.
3. Study of Amplitude Shift Keying (ASK).
4. Study of Frequency Shift Keying (FSK).

5. Simulate Phase Shift Keying (PSK)- Binary Phase Shift Keying (BPSK)- and Quadrature Phase Shift Keying (QPSK) using software.
6. Study of Quadrature amplitude Modulation (QAM).
7. Study the Hamming Code-7bit generation.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than six.

Essential/recommended readings

1. W. Tomasi, Electronic Communication Systems: Fundamentals through Advanced, Pearson Education (2024), 5th Edition
2. S. Haykin, Digital Communication, John Wiley India (Circa 2021), 3rd Edition
3. B. Sklar, Digital Communication, 2nd Edition, Pearson Education (2024)
4. J.G. Proakis, Fundamentals of Communication Systems, Pearson Education (2024), 2nd Edition

Suggestive readings

1. L. W. Couch II, Digital and Analog Communication Systems, Pearson Education (2005)
2. H. P. Hsu, Analog and Digital Communications, Tata McGraw Hill (2006)

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-4)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Optical Communication System ELDSE7D	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	-

Learning Objectives

This course introduces the student to the fundamentals of optical communications, including the optical sources at the transmission station, the transmission medium, and the optical detectors at the reception station. The course aims to develop an understanding of the LASERS, optical amplifiers, and design considerations of a fiber optic communication systems, bit error rate and rise time budgeting and power budgeting.

Learning outcomes

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

- Describe the difference between LED and Laser diode (LD) and choose a proper light source for optical communication.
- Understand the design of an optical communication system, to calculate the power requirements for a given fiber optic communication link, and hence compute loss and dispersion.
- Understand various low loss optical communication windows, importance of 1330nm and 1550nm wavelengths in optical communications.
- Understand optical fiber amplifier including erbium doped fiber amplifier.

SYLLABUS OF ELDSE-7D **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (12 Hours)

Sources for optical fiber communication: Optical Communication requirements, LASER fundamentals: Absorption and emission of radiation, condition for amplification of radiation, LASER oscillations. Basics of semiconductor lasers, laser diode characteristics, LED characteristics.

UNIT – II (10 Hours)

Detectors for optical fiber communication: Principle of optical detection, PIN photodetector, responsivity and quantum efficiency, speed of response, avalanche photodetector

UNIT – III (12 Hours)

Design considerations of fiber optic communication system: Characterization of an optical fiber: measurement of its radius, numerical aperture, cut-off wavelength (Marcuse's formula) Analog and digital modulation (direct), noise in detection process: shot noise, thermal noise, SNR, Bit error rate (BER), system design: power budgeting, rise time budgeting

UNIT – IV (11 Hours)

Optical Fiber amplifiers: Wavelength dependence of loss and dispersion of a single mode fiber and various loss windows: significance of 1300nm and 1550nm wavelength in optical communications. Introduction to semiconductor optical amplifiers, Block diagram of an optical amplifier at 1550nm communication wavelength, Optical amplification, absorption and emission cross-sections for a typical erbium doped fiber amplifier, Energy levels of erbium ions in silica matrix

Practical component (if any) – Optical Communication System Lab
(Hardware and/or software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Perform experiments based on LEDs and laser diodes.
- Characterize an optical fiber in terms of measuring its radius, numerical aperture, and cut-off wavelength.
- Design an optical link and calculate the power budgeting.
- Understand an optical fiber amplifier.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To study the characteristics of LED.
2. To study the characteristics of semiconductor laser diode.
3. To study the characteristics of Silicon and Germanium photo-detectors.
4. To couple optical light into SMF and MMF and study the fundamental mode pattern and the speckle pattern.
5. To measure the parameters of a single mode optical fiber: radius, numerical aperture, cut-off wavelength.
6. To design an optical communication link and study power budgeting (simulation).
7. To design an optical circuit showing direct analog and digital modulation schemes.
8. To study the bending losses in an optical fiber link.
9. To study an EDFA (simulation).
10. Study of an OTDR instrument.

ONLINE virtual lab:

1. Amrita Vishwa Vidyapeetham Virtual Lab
2. Virtual Labs ofcvlab.vesit.ves.ac.in

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than nine.

Essential/recommended readings

1. Ajoy Ghatak and K Thyagarajan, Introduction to Fiber Optics, Cambridge University Press, New Delhi (2024)
2. D.K. Mynbaev and Lowell L. Scheiner, Fiber-Optic Communication Technology, Pearson Education (2024).

Suggestive readings

1. J. M. Senior, Optical fiber communication systems: principles and practice, Pearson Education in south Asia, (2009).
2. J. Gower, Optical communication systems, Pearson Education
3. G. Keiser, Optical communications, McGraw Hills education (2003)
4. M. R. Shenoy, S. K. Khijwania, et al., Fiber optics through Experiments, Viva books (2011)

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-5)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
CMOS Digital VLSI Design ELDSE7E	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Digital Electronics, Analog Electronics-I & II, Basic VLSI Design

Learning Objectives

This course introduces the student to develop the ability to design and analyze combinational and sequential digital circuits using VHDL/Verilog; design methodologies of memory circuits such as SRAM and DRAM; acquire hands-on skills in layout design and to simulate and analyze VLSI circuits, including post-layout simulations

Learning outcomes

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

- Design and analyze CMOS-based combinational and sequential circuits, focusing on performance metrics like power, delay, and reliability.
- Design and evaluate memory circuits, including SRAM and DRAM, considering trade-offs in stability, speed, and power.
- Demonstrate proficiency in creating and verifying layouts of digital circuits, ensuring adherence to design rules and industry standards.
- Utilize EDA tools for circuit design, simulation, and layout verification.

SYLLABUS OF ELDSE-7E **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (12 Hours)

HDL: History of HDL; Structure of VHDL; VHDL Modules : entity, architectures, concurrent signal assignment; Data Flow Modelling, Structural Modelling, Behavioural Modelling.

UNIT – II (14 Hours)

Verilog: Verilog/VHDL Comparisons; Module, Data Types, Operators and Expressions, Instantiation and Hierarchical Design, Blocking and Non-Blocking Assignments, Gate Level, Dataflow and Behavioural Modelling, RTL, Verilog Tasks and Functions, Design Flow and Verilog Test Bench

UNIT – III (10 Hours)

SRAM and DRAM : 6T SRAM cell design and read & write-operation, stability analysis and noise margins, stick diagram of a traditional 6T SRAM cell, DRAM architecture and refresh mechanism, DRAM Architecture - One-transistor, Three-transistor and Four-Transistor DRAM cell, DRAM subarray -Open and Folded Bitlines.

UNIT – IV (09 Hours)

Layout Design Rules and DRC : basic layout design rules, metal layers, contacts, and vias in CMOS layouts, design rule checks, layout versus schematic, Inverter Cell Layout. Introduction to - post-layout simulation; parasitic extraction; full-custom layout design; concept of standard cell & parameterized cells; importance of VLSI CAD tools; ASIC design flow vs. FPGA flow.

Practical component (if any) – Digital VLSI Design Lab

(Practicals to be performed using VHDL/Verilog, Ngspcie/LTspice/QUCS, kiCAD/MagicVLSI, XCircuit, OpenRAM, CADENCE/MENTOR GRAPHICS)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Apply VHDL/Verilog to design the Digital Circuits
- Get familiarized with the VLSI design Simulation Tools
- Create Layout of a CMOS inverter and perform design rule checks (DRC).

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Design Full Adder/Subtractor using VHDL.
2. Design a Counter using VHDL.
3. Design MUX/Multiplier Circuit using Verilog
4. Design ALU using Verilog
5. Design a 6T SRAM cell, simulate its read/write operation.

6. Draw the stick diagram for a CMOS inverter and basic gates like NAND and NOR.
7. Create the layout of a CMOS inverter, ensuring compliance with basic design rules. Perform design rule checks (DRC).
8. Perform post-layout simulation for a CMOS inverter, including parasitic extraction. Analyze the impact of parasitics on circuit performance.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than seven.

Essential/recommended readings

1. J. Bhasker, A Verilog® HDL Primer, BSP, 3rd Edition, 2024, ISBN: 9788178001425
2. Samir Palnitkar: Verilog HDL-A guide to digital design and synthesis-, Pearson, 2003, ISBN- 0-13-044911-3 / 978-0130449116
3. Wayne Wolf: Modern VLSI Design: IP-Based Design, PHI, 4th Edition, 2015, ISBN-9780137145003
4. Weste and Harris: CMOS VLSI Design: Circuits and Systems Perspective, Pearson/Addison-Wesley,4th Edition, 2010, ISBN- 9780321547743
5. Kang and Lebelbigi: CMOS Digital IC Circuit Analysis and Design, McGraw-Hill Education, 4th Edition, 2014, ISBN- 9780073380629

Suggestive readings

1. Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic: Digital Integrated Circuits: A Design Perspective, Prentice Hall Electronics, 2003, ISBN-10 0130909963; ISBN-13 978-0130909961
2. Randall L. Geiger, Phillip E. Allen, and Noel R. Strader: VLSI Design Techniques for Analog and Digital Circuits, McGraw Hill, 1989, ISBN-10 0070232539; ISBN-13 978-0070232532

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-6)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Nanoscience ELDSE7F	**4**	**4**	**-**	**-**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**-**

Learning Objectives

This course introduces the student about nanoscience, which includes the fundamental understanding of effect of size and the related physics involved behind it. They will study fundamentals of quantum physics and its applications in nanoengineering and properties of nanostructures as well as nanomaterials.

Learning outcomes

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

- Develop the fundamental base of nanoscience.
- Acquire knowledge of effect of size and the related physics involved behind it.
- Understand the behavior and properties of nanomaterials.

SYLLABUS OF ELDSE-7F **Total Hours- Theory: 60 Hours**

UNIT – I (13 Hours)

Introduction to Nanoscience: Definition and Importance of Nano, Opportunities at nano scale, Scientific revolution- emergence and challenges of nanomaterial and nanotechnology with examples (daily life, health care and energy)

Implications of Nanoscience and Nanotechnology on Society, Harnessing Nanotechnology for Economic and Social Development

Influence of nano over micro/macro, surface to volume ratio-dangling bonds, chemical activity of nanoparticulates, sensing applications with example of graphene. Size effects-idea about electronic wave function, Population of the conduction and valence bands, Quasi Fermi levels, examples of metal nanoparticles.

UNIT – II (17 Hours)

Fundamentals of Quantum Theory: Origins of Quantum Physics, Particle properties of waves: Black body radiation, Photoelectric effect, Compton Effect; Wave properties of particles: De Broglie waves, Wave description, Particle diffraction, The Wave Particle Duality, The Uncertainty Principle, The Wave Packet and the Wave Function, The Schrödinger Equation, The Expectation Value, The Free Particle Solution, The Linear Harmonic Oscillator Problem, The Kronig-Penney Model for Electron in a 1-Dimensional Lattice

UNIT – III (13 Hours)

Quantum Nanoengineering:

Particle in a Box, Quantum Limit: From 3D to 0D, Quantum Confinement in Semiconductors: Potential Step, Potential Barrier, Quantum Well. Atomic structure: Electron orbits, The Bohr atom; Quantum Structure: 2D (Quantum well), 1D (Quantum Wires), 0D (Quantum Dots);

3D Density of States, 2D Model- Energy Eigen values and Density of States, 1D Model-Energy Eigen values and Density of States, Q0D Model- Energy Eigen values

UNIT – IV (17 Hours)

Quantum Effect on Properties of Nanostructures and Nanomaterials: Melting Point-Variation in bulk vs nanoparticles, nanowires, nanosheets, superheating, liquid drop model (Quantitative); Electronic structure and Optical Properties-band gap dependence on the size of the nanoparticles(quantitative), concept of excitons; Mechanical Properties- ductility, strain hardening, yield stress, dynamic response, creep(qualitative); Dielectric Properties- particle size dependence of refractive constant, extinction coefficient (quantitative), Magnetic Properties-idea about diamagnetism, paramagnetism, ferromagnetism, Curie temperature, remanent magnetization, coercive field; saturated magnetization and its dependence on size and temperature(quantitative)

Size dependent electronic Properties (Classification of materials based on band structures - Brillouin zone – Effect of temperature, Quantized conduction, Ballistic transport, Coulomb blockade).

Practical component (if any) – None

Essential/recommended readings

1. Introductory Nano science by Masuro Kuno, Garland science (2011)
2. Concepts of Modern Physics by Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, MedTech Science Press, 8^{th} Edition, 2024
3. Nanophysics and Nanotechnology by Edward L. Wolf Wiley-VCH-2006
4. Nanotechnology: Principles & Practices, S.K. Kulkarni, Springer, 2015.

Suggestive readings

1. Introduction to Nanomaterials and Devices: Omar Manasreh (Wiley), 2011
2. Introduction to Nano, Basics to Nanoscience and Nanotechnology, Amretashis Sengupta, Chandan Kumar Sarkar Editors, 2015, Springer, ISBN 978-3-662-47313-9
3. Textbook of Nanoscience and Nanotechnology, B S Murty and others, 2013, Springer, e-ISBN 978-3-642-28030-6

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-7)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Advanced Embedded System Design with ARM ELDSE7G	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	

Learning Objectives

The course aims to introduce students to ARM microcontroller architectures. Students will gain an understanding of the core features, instruction sets, and peripheral interfacing capabilities of ARM Cortex-M3 microcontrollers. The course further intends to equip students with practical skills in assembly and embedded C programming, along with foundational knowledge of real-time operating systems (RTOS), enabling them to design, develop, and troubleshoot embedded systems effectively.

Learning outcomes

On successful completion of the course, student will be able to:

- Describe the architectural features and instructions of ARM Cortex-M3 microcontroller.
- Apply the knowledge gained for programming ARM Cortex-M3 to interface peripherals for different applications.
- Apply RTOS concepts such as task scheduling, synchronization, interrupts, and timers in embedded systems.
- Analyze and debug embedded system applications using ARM Cortex-M3 microcontrollers.

SYLLABUS OF ELDSE-7G **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

Unit – I (11 lectures)
ARM Microcontroller Architecture:
Introduction to ARM microcontroller families, features, and applications. Thumb-2 technology, Architecture of ARM Cortex-M3, various units in the architecture, General Purpose Registers, Special Registers, Exceptions, Interrupts, Stack Operation, Reset Sequence, Debugging Support.

Unit – II (11 lectures)
ARM Cortex-M3 Instruction Set:
Assembly basics, Addressing Modes, Instruction lists and description, Thumb and ARM instructions, Special instructions, Useful instructions, CMSIS, simple assembly language programs.

Unit - III (11 lectures)
ARM Cortex-M3 Peripherals:
ARM Cortex M3 Peripherals: GPIO control, Timer configurations, and basic Interrupt handling, Introduction to Embedded C programming for ARM. Peripheral programming in Assembly and Embedded C language.

Unit - IV (12 lectures)
RTOS Based Embedded System Design:
Operating System Basics, Types of Operating Systems, Architecture of an RTOS, Important features of RTOS, Embedded Systems Programming, Locks and Semaphores, Operating System Timers and Interrupts, Exceptions, Tasks. Task states and scheduling, Synchronization, Real-time clock and system clock.

Practical component (if any) – Advanced Embedded System Design with ARM Lab
(Practicals to be performed using Hardware/Simulator)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Write Assembly language/C Language program for ARM Processor.
- Able to interface and program peripherals like LED, actuators, LCD display etc. on ARM Ports.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Write a program to perform arithmetic operations on two 32-bit numbers.
2. Write a program to generate an A.P. / G.P. / Fibonacci series.

3. Write a program to sort a given list of 32-bit numbers in ascending/descending/reverse order.
4. Write a program to configure and blink / toggle GPIO pins at a specific rate.
5. Write a program to design a counter (decade, hexadecimal, etc.) on an LCD / 7-segment display.
6. Write a program to read a 4×4 keyboard and display the key code on an LCD / 7-segment display.
7. Write a program to generate PWM signals to control the brightness of an LED.
8. Write a program to control the speed of a DC motor
9. Design RTOS Based Parameter Monitoring and Controlling System for collecting the data from sensor interfaced with microcontroller.
10. Implement a real-time clock using RTOS timers

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than nine.

Essential/recommended readings

1. Joseph Yiu, "The Definitive Guide to ARM CORTEX - M3 and CORTEX M4 Processors" 3rd Edition, Newnes, (Elsevier), 2014. ISBN: 978-0124080829.
2. K.V.K.K Prasad, "Embedded Real Time Systems", Dreamtech Publications, 2003. ISBN: 978-8177224610
3. Raj Kamal, "Embedded Systems", 3rd Edition, McGraw Hill Publications, 2017. ISBN: 978-9332901490
4. Colin Walls, "Embedded RTOS Design: Insights and Implementation", 1st Edition, Newnes, (Elsevier), 2020. ISBN: 978-0128228517

Suggestive readings

1. Yifeng Zhu, "Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C", 3rd Edition, E-Man Press LLC, 2017, ISBN: 978-0982692660
2. Jonathan W. Valvano, "Embedded Systems: Real-Time Operating Systems for ARM Cortex-M Microcontrollers", 2nd Edition, Createspace Independent Pub, 2012. ISBN: 978-1466468863

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.