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# SEMESTER-VI

UNIVERSITY OF DELHI

CNC-II/093/1(26)/2023-24/179
Dated: 13.09.2023

**NOTIFICATION**

Sub: Amendment to Ordinance V

[E.C Resolution No. 14/ (14-1-4) dated 09.06.2023]

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

**Add the following:**

**Syllabi of Semester-IV, V and VI of the following departments under Faculty of Interdisciplinary and Applied Sciences based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23.**

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# SEMESTER-VI
# DEPARTMENT OF ELECTRONIC SCIENCE
## Category I

**(B.Sc. Honours in Electronics)**

## DISCIPLINE SPECIFIC CORE COURSE – 16: Digital Signal Processing

### 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 Signal Processing | 4 | 3 | - | 1 | Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices | Signals and Systems (DSC 9, Sem III) |

### Learning Objectives

The Learning Objectives of this course are as follows:
To introduce the techniques of modern digital processing that are fundamental to a wide variety of application areas. Special emphasis is placed on the basic concepts related to discrete-time signals and systems, the analysis of signals in time and frequency using Fourier and Z transform. Introduction to techniques involved in the architecture and design of digital filters.

### Learning outcomes

The Learning Outcomes of this course are as follows:

- Grasp fundamentals of discrete time signals, linear time-invariant systems, Z-transform and Fourier transform
- Analyze linear time-invariant systems using Fourier and Z transform

- Understand the Design techniques of Digital FIR and IIR filters using direct methods and methods involving conversion of the analog filter into the digital filter by various transformations.
- Use DFT to perform frequency analysis of signals and application of FFT algorithms.

**SYLLABUS OF ELDSC-16** **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

**UNIT – I ( 10 Hours)**

**Discrete Time Sequences and Systems:** Introduction to Discrete Time sequences, Properties of DT systems.

**Fourier Transform:** Fourier Transform, Properties of Fourier Transform, Inverse Fourier Transform, Transfer Function of LSI systems.

**UNIT – II (12 Hours)**

**Z-Transform:** Definition, Unilateral Z- transform, Region of Convergence and its properties, Properties of Z-Transform, Initial and final value theorem.

Inverse Z Transform: Long division, Partial fraction, and Residual methods. Parseval's Theorem and applications.

**System Function:** Linear constant coefficient difference equation, Representation and analysis of Discrete Time Systems, Stability, Causality, Realisation of Digital Linear Systems: Block diagram, signal flow graph, structure for IIR and FIR systems

**UNIT – III (12 Hours)**

**Discrete Fourier Transform:** DFT assumptions and Inverse DFT, magnitude and phase representation Matrix relations, relationship with Fourier Transform, Linear and circular convolution, properties of DFT, Computation of DFT. FFT Algorithms-Decimation in time FFT. Decimation in frequency FFT, FFT using radix 2 FFT — Butterfly structure, Concept of Gibb's phenomenon and word length effects.

**UNIT – IV (11 Hours)**

**Digital Filters:** Comparison of Analog and Digital Filters, Types of Digital Filters: FIR and Hanning, Hamming, Blackman, Design of IIR Filters by Approximation of Derivates, Impulse Invariant Method, Bilinear Transformation, Butterworth Filter.

**Practical component (if any) – Digital Signal Processing**
***(Scilab/MATLAB/Python other Mathematical Simulation software)***

**Learning outcomes**

The Learning Outcomes of this course are as follows:

- Simulate, synthesize and process signals using a software tool.

- Apply transform methods for representing signals and systems in the time and frequency domain.
- Simulation and design of FIR and IIR Filters

**LIST OF PRACTICALS ( Total Practical Hours- 30 Hours)**

1. Write a program to generate discrete time Unit Sample, Unit Step, Unit ramp and Sinusoidal sequences.
2. Write a program to find the Fourier Transform of a sequence.
3. Write a program to find the pole-zero plot of a function.
4. Write a program to find a function's Z transform and inverse Z transform.
5. Write a program to find the circular convolution of two sequences.
6. Write a program to find the DFT of a sequence using the direct method.
7. Write a program to find the DFT of a sequence using FFT.
8. Magnitude Response of Low Pass Filter and High Pass Filter.
9. Design FIR Filter using Window Function.
10. Convert Analog Filter to Digital IIR Filter

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. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1999.
2. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall, 2007.

**Suggestive readings**

1. S. Salivahanan, Digital Signal Processing, McGraw Hill, 2015.
2. Tarun Kumar Rawat, Digital Signal Processing, Oxford University Press, 2015.
3. Monson Hayes, Digital Signal Processing: Second Edition, Schaum's Outline Series

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

## DISCIPLINE SPECIFIC CORE COURSE – 17: Photonics

### 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 | | |
| Photonics | 4 | 3 | - | 1 | Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices | Electro-magnetics (DSC 14, Sem V) |

### Learning Objectives

The Learning Objectives of this course are as follows:

- This course introduces the student to the fundamental understanding of light as an electromagnetic wave and various phenomenon like interference, diffraction and polarization and their applications.
- Interaction between a photon and electron and its relevance to laser and various other optoelectronic devices.
- Understand the propagation of wave in planar optical waveguides and optical fibers.

### Learning outcomes

The Learning Outcomes of this course are as follows:

- Describe the optics and simple optical systems.
- Understand the concept of light as a wave and its propagation in optical fibres, and relevance of this to optical effects such as interference , diffraction, polarization and hence to lasers, holography and optical waveguides.
- Use mathematical methods to predict optical effects with e.g. light-matter interaction, wave propagation in guided media, dispersion, wave optics

### SYLLABUS OF ELDSC-17 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

**UNIT – I ( 12 Hours)**

**Light as an Electromagnetic Wave:** Plane waves in homogeneous media, concept of spherical waves. Reflection and transmission at an interface, total internal reflection, Brewster's Law.
**Interference** :Interference by division of wavefront, Young's double slit, Division of Amplitude, thin film interference, anti-reflecting films, Newton's rings.
**Diffraction:** Fraunhoffer Diffraction by a single slit, double slit, Diffraction grating: Resolving power and Dispersive power

**UNIT – II (11 Hours)**
**Holography:** Basic Principle , Construction and reconstruction of hologram.
**Polarization:** Linear, circular and elliptical polarization, polarizer-analyzer and Malus' law; Double refraction by crystals, Half wave and quarter wave plates. Electro optic Effect, Faraday Rotation
**Liquid Crystal Displays:** Types, Working Principle.

**UNIT – III (11 Hours)**
**Light Emitting Diodes:** Construction, materials and operation.
**Lasers:** Interaction of radiation and matter, Einstein coefficients, Condition for amplification, Laser cavity , Examples of common lasers. The semiconductor injection laser diode.
**Photodetectors:** Photo transistors and Photodiodes (p-i-n, avalanche), quantum efficiency and responsivity.

**UNIT – IV (11 Hours)**
**Guided Waves and the Optical Fibre:** Maxwell's Equations, TE modes in symmetric step index planar slab waveguides, effective index, field distributions, Step index optical fibre, total internal reflection, single mode and multimode fibres, attenuation and dispersion in optical fibres.

**Practical component (if any) – Photonics**
***(Hardware Lab augmented with virtual lab)***

## Learning outcomes

The Learning Outcomes of this course are as follows:

- Perform experiments based on the phenomenon of light/photons.
- Measure the parameters such as wavelength, resolving power, numerical aperture etc. using the appropriate photonic/optical technique.
- Prepare the technical report on the experiments carried.

## LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To determine Brewster's angle.
2. To determine wavelength of sodium light using Newton's Rings.
3. To determine the resolving power and Dispersive power of Diffraction Grating.
4. Diffraction experiments using a laser.

5. Viewing of different types of holograms.
6. To verify the law of Malus for plane polarized light.
7. Study of Faraday Rotation.
8. Study of Electro-optic Effect.
9. To determine characteristics of LEDs and Photo- detector.
10. To measure the numerical aperture of an optical fiber.

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.

In addition to the above hardware lab , teaching learning process can be further augmented using following/any other ONLINE virtual labs:

- Amrita Vishwa Vidyapeetham Virtual Lab https://vlab.amrita.edu/
- Virtual Labs ofcvlab.vesit.ves.ac.in

**Essential/recommended readings**

1. Ajoy Ghatak, Optics, Tata McGraw Hill, New Delhi (2005)
2. E. Hecht, Optics, Pearson Education Ltd. (2002)
3. Ghatak A.K. and Thyagarajan K., —Introduction to fiber optics, Cambridge Univ. Press. (1998)

**Suggestive readings**

1. J. Wilson and J. F. B. Hawkes, Optoelectronics: An Introduction, Prentice Hall India (1996)
2. S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson Education (2009)

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

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## DISCIPLINE SPECIFIC CORE COURSE – 18: Semiconductor Device Technology

### 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 | | |
| Semiconductor Device Technology | 4 | 3 | - | 1 | Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices | Semi-conductor Devices (DSC 3, Sem I) |

### Learning Objectives

The Learning Objectives of this course are as follows:

- The course deals with properties of materials required for Semiconductor Devices
- It deals with various processing steps
- It gives an account of how the Semiconductor Devices are fabricated (with details of all processes involved)

### Learning outcomes

The Learning Outcomes of this course are as follows:

- Summarize the developments in the field of microelectronics technologies
- Describe the crystal growth, diffusion, oxidation, lithography, etching and various film deposition processes.
- Explain the process sequence for PN junction, BJT, CMOS and BiCMOS fabrication

### SYLLABUS OF ELDSC-18 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

**UNIT – I ( 11 Hours)**

**Semiconductor materials:** Single crystal, polycrystalline and amorphous forms. Properties of Silicon and Gallium Arsenide. Materials used for doping Silicon and Gallium Arsenide

**Crystal growth techniques:** Starting material ($SiO_2$), MGS, EGS, Growth of bulk Silicon single crystals using Czochralski (CZ) technique, Doping while crystal growth (Distribution of dopants, Effective Segregation Coefficient), Float Zone (FZ) technique, GaAs bulk single crystal growth by LEC technique, Bridgman-Stockbarger technique.
**Wafer Cleaning Technology :** Basic Concepts, Wet cleaning, Dry cleaning

**UNIT – II (12 Hours)**
**Epitaxy Deposition:** Vapor-Phase Epitaxy, Molecular Beam Epitaxy, Growth of GaAs films by MOCVD.
**Oxidation:** Importance of Silicon Dioxide in Silicon, Thermal Oxidation Process, Kinetics of Growth for thick and thin Oxide, Dry and Wet oxidation. Effects of high pressure and impurities on oxidation rates, Impurity redistribution during Oxidation, Oxide Quality, Chemical vapour deposition of silicon oxide, properties of silicon oxide, step coverage, P-glass flow

**UNIT – III (11 Hours)**
**Diffusion:** Thermal Diffusion, Diffusion Equation, Diffusion Profiles. Extrinsic Diffusion Concentration Dependent Diffusivity, Lateral Diffusion, Doping through Ion Implantation, and its comparison with Thermal Diffusion.
**Lithography:** Clean room, Optical Lithography, Electron beam lithography, Photoresist, Photo masks, Wet Chemical Etching, Common etchants

**UNIT – IV (11 Hours)**
**Metallization:** Filament evaporation, e-beam evaporation, sputtering techniques used for metals (Aluminium, Gold, Copper etc..) deposition on Silicon and GaAs
**Process Integration (IC)**: Isolation techniques. Fabrication of Monolithic Resistor, Inductor, Capacitor. PN junction, BJT, NMOS, PMOS, CMOS structures.
Concept of Bipolar Technology and MOSFET Technology for Devices

**Practical component (if any) – Semiconductor Device Technology**
***(Scilab/MATLAB/other Simulation Software)***

## Learning outcomes

The Learning Outcomes of this course are as follows:

- Operate the advanced computer simulations tools as well as visit research laboratories for better understanding of semiconductor fabrications processes.
- Perform the simulation of semiconductor crystal growth and device fabrication processes like oxidation and diffusion.
- Perform experiments to calculate the electronic parameters like resistivity, mobility, carrier concentration and band gap etc in semiconductors.
- Operate the deposition system for fabrications of thin films

## LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To measure the resistivity of semiconductor crystal with temperature by four – probe method.

2. To determine the type (n or p) and mobility of semiconductor material using Hall effect.
3. CZ technique Simulation
4. Float zone technique Simulation
5. Oxidation process Simulation
6. Diffusion Process Simulation
7. To design a pattern using photolithographic process and its simulation
8. Process integration simulation
9. Determination of Optical Bandgap through transmission spectra.
10. Visit to Research Lab/institutions to see the live demonstrations of the processes and preparation of a report.

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. Gary S.May and S.M.Sze , Fundamentals of Semiconductor Fabrication, John Wiley& Sons(2004)

**Suggestive readings**

3. Ludmila Eckertova, Physics of Thin films, 2nd Edition, Plenum Press (1986).

**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

### 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 | | |
| Medical Electronics & Instrumentation | 4 | 3 | - | 1 | Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices | Basic Instrument-ation & Measure-ment Techniques (DSC 4, Sem II), Micro-processor (DSC 11, Sem IV) |

### Learning Objectives

- This course introduces the student to the fundamental understanding of various types of Biomedical Signals and their physiological aspects.
- The students analyse the various types of Biomedical instruments and their working and practical implementation.
- Learn about Modern Imaging systems like CT and MRI techniques and various other cardiac instruments.
- Learn about Instrumentation for clinical lab: blood cell counter, oximeter, blood gas and blood ph analyser.
- Learn about the emerging fields like EEG, ECG, EMG etc.
- To learn about patient safety and precaution for instruments and electrodes.

### Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic knowledge of physiology and generation of bio electric signals (ECG, EMG, EEG etc.) in humans.
- Describe cardio vascular monitoring systems , Bed side monitor, ECG-Telemetry.
- Describe the basic knowledge on respiratory and pulmonary measurements.
- Describe modern methods of imaging techniques like CT, X-Ray, NMR and MRI.

- Describe conditions for patient safety
- Describe instrumentation for clinical Lab like Blood cell counters, oximeter, blood gas and blood pH analyser..

**SYLLABUS OF ELDSE-4A** **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

**UNIT – I ( 10 Hours)**

**Biomedical signals and transducers**

**Physiological systems of human body:** Introduction, Origin of biomedical signals, Use of microprocessors, Microcontrollers and computers in medical instruments, **Transducers:** Ultrasound transducer, Radiation and chemical thermometry, optical fibre sensor, biosensors, optical glucose sensor, Electrodes & its types: for ECG, EMG & EEG

.

**UNIT – II (12 Hours)**

**Cardiovascular monitoring systems:** Patient cardiovascular Monitoring systems Cardiovascular System, blood pressure measurement, cardiac rate and output measurement, Cardiac monitor- Waveforms, ECG amplifier, phonocardiography, Ballisto cardiography, Eco-Cardiograph, Bed side monitor –block diagram- measuring parameters-cardiac tachometer-Alarms-Lead fault indicator-central monitoring. Telemetry – modulation systems – choice of carrier frequency – single channel telemetry systems, Cardiac pacemakers: Introduction, Cardiac defibrillators

**UNIT – III (12Hours)**

**Imaging Systems**

**X-rays:** Properties and production, Block diagram of x-ray machine, Diagnostic radiology, Dental X-ray, Basic principle and components of X-Ray Computed Tomography (CT)

**MRI:** Principle and NMR imaging components

Introduction to Ultrasonic imaging system.

**UNIT – IV (11 Hours)**

**Patient's safety:** Precaution, safety codes for electro medical equipment, Electric safety analyser, Testing of biomedical equipment.

**Instrumentation for Clinical Laboratory:** Blood cell counters, Oximeter, Blood flow meter, Blood gas analysers, Blood pH analyser.

**Measurement in Respiratory system:** Physiology of respiratory system, Measurement of breathing mechanics Spiro meter, Respiratory therapy equipment Inhalators ventilators & Respirators, Humidifiers, Nebulizers Aspirators.

**Practical component (if any) – Medical Electronics & Instrumentation**

## Learning outcomes

The Learning Outcomes of this course are as follows:

- Familiarize with functioning of biomedical instrumentation
- Perform experiments on the biomedical instruments, collect & analyze the data
- Prepare the technical report on the experiments carried

## LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To simulate Bio potential Amplifier.
2. Study on ECG simulator.
3. Study on EEG simulator.
4. Study on EMG simulator.
5. Study of various leads and electrode position for ECG and EEG.
6. Study of pulse rate monitor (Pulse oximetry).
7. To simulate defibrillator.
8. Measurement of heart sound using electronic stethoscope.
9. Simulation of blood cell counter.
10. Study of NMR using virtual lab.
11. Visit to a Diagnostic lab/Pathology lab/Hospital to understand working of various instruments and preparation of a report.

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 ten.

**Essential/recommended readings**

1. Khandpur R. S. - Handbook of Biomedical Instrumentation, TMH.
2. Joseph J. Carr & John M. Brown, Introduction to Biomedical Equipment Technology, Pearson.
3. Shakti Chatterjee, —Textbook of Biomedical Instrumentation System‖, Cengage Learning.
4. Prof. S.K.VenkataRam-Bio-Medical Electronics and Instrumentation, Galgotia Publications.

**Suggestive readings**

1. Bertil Jacobson & John G. Webster - Medicine and Clinical Engineering, PHI.

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## 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 | | |
| Advance Computer System Architecture | 4 | 3 | - | 1 | Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices | Microprocessor (DSC 11, Sem IV) or equivalent to Computer System Architecture, Operating system(DSE 2B, Sem IV) |

### Learning Objectives

- To give the students an elaborate idea about the different memory systems and buses.
- To introduce the advanced processor architectures to the students.
- To make the students know about the importance of multiprocessor and multicomputer.
- To study about data flow computer architectures
- To make students know about the Parallelism concepts

### Learning outcomes

The Learning Outcomes of this course are as follows:

- Demonstrate concepts of parallelism in hardware/software.
- Discuss memory organization and mapping techniques.
- Describe architectural features of advanced processors.
- Interpret performance of different pipelined processors.
- Explain data flow in arithmetic algorithms
- Development of software to solve computationally intensive problems.

### SYLLABUS OF ELDSE-4B Total Hours- Theory: 45 Hours, Practicals: 30 Hours

**UNIT – I ( 10 Hours)**

**Computer Architecture & Organization:** Instruction codes, Computer instructions, Basics of Input/Output & Interrupts, Complete computer description & design of basic

computer. Control Unit: Hardwired vs. Micro programmed control unit. Flynn's classification.

**UNIT – II (11 Hours)**

**Memory Hierarchy:** Hierarchical memory organization, Types of Cache Memory, Memory Interleaving, Replacement algorithms + write policy, Concept of Virtual Memory and Virtual Machine.

**Parallel Processing:** Definition, Theory of Parallelism. Parallel Computer Models, Implicit Parallelism vs. explicit parallelism, Levels of parallelism. Software Parallelism, Hardware Parallelism.

**UNIT – III (12 Hours)**

**Pipelining:** Basic Concepts of pipelining, Linear pipeline processor, Asynchronous and Synchronous models, speed up, Efficiency, Throughput, Instruction pipeline. Pipeline hazards and their Resolution Mechanisms like data forwarding, Delayed Branch, Branch Prediction, Dynamic Branch Prediction, Concept of Vector processing.

**UNIT – IV (12 Hours)**

**Instruction Level Parallelism (ILP) Instruction-level Parallelism:** Introduction, Challenges, Limitations, Basic Compiler Techniques for ILP, Branch Prediction, Out of order execution, Dynamic Scheduling, Limitations of ILP. Introduction to Thread Level Parallelism (TLP) and Data Level Parallelism (DLP). Introduction to Virtualisation Architecture, Virtualisation as a concept of Cloud Computing.

**Practical component (if any) – Advance Computer System Architecture**
***(FPGA/Virtual Lab/Tejas Architecture Simulator)***

**LIST OF PRACTICALS ( Total Practical Hours – 30 Hours)**

1. To design a 4-bit common bus using 4:1 mux to transfer data from register to bus.
2. To design a 2-bit combinational shifter circuit which implements the logical shift, circular shift, arithmetic shift for both direction.
3. To design 2 bit arithmetic circuit which performs the following arithmetic operations add, add with carry, subtract, subtract with borrow, increment and decrement.
4. Design of Arithmetic Logical Unit ALU
5. Design of Memory: Design of a RAM cell
6. Design of Memory: Design of a 4X4 RAM
7. Design of Direct Mapped Cache
8. Design of Associative Cache
9. Using Architectural Simulator Tejas as
    a. Emulator
    b. Transfer Engine

c. Translational Modules
d. Micro architectural Simulation

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, experiment no. 9 is compulsory.

**Essential/recommended readings**

1. "Computer Architecture: A Quantitative Approach", by John L. Hennessy and David A. Patterson, Morgan Kaufmann, 5th edition, 2011, ISBN: 9780123838728.
2. "Computer System Architecture" by M. Morris Mano (Pearson Publication)

**Suggestive readings**

1. "Computer Organization and Architecture", William Stallings, Prentice Hall, 10th edition, 2015, ISBN-10: 013293633X, ISBN-13: 978-0132936330
2. "Advanced computer architecture", Kai Hwang, TMH. 2000

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## 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 | | |
| Transmission Lines, Antenna and Wave Propagation | 4 | 3 | - | 1 | Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices | Electromagnetics (DSC 14, Sem V) |

### Learning Objectives

The Learning Objectives of this course are as follows:

- Fundamentals of propagation of electromagnetic waves.
- Basics of transmission lines along with its parameters.
- Wave propagation in different modes of the waveguides.
- Antenna parameters and its radiation mechanism.

### Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand reflection and transmission of uniform plane wave.
- Explain the functioning of transmission line and its performance parameters.
- Understand wave propagation in waveguides and different modes of propagation.
- Explain the radiation mechanism and characteristics of an antenna.

**SYLLABUS OF ELDSE-4C** **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

**UNIT – I ( 11 Hours)**

**Electromagnetic Wave Propagation:** Plane Wave reflection at Oblique Incidence:- Laws of Reflection, Snell's Law of Refraction, Parallel and Perpendicular polarisations, Fresnel's Equations and Brewster Angle, Wave propagation in dispersive media, Concept of phase velocity and group velocity

**UNIT – II (11 Hours)**

**Transmission Lines:** Typical Transmission lines- Coaxial, Two-Wire, Microstrip and Coplanar, Transmission Line Parameters, Transmission Line Equations, Wave propagation in Transmission lines:- lossy, lossless and Distortionless lines, Input Impedance, Standing Wave Ratio, Power, Shorted Line, Open-Circuited Line and Matched Line, Quarter wave transformer as transmission line application.

**UNIT – III (11 Hours)**

**Waveguides:** Introduction to Parallel plate waveguide, Rectangular waveguide, Transverse Electromagnetic (TEM), Transverse Magnetic (TM) and Transverse Electric (TE) modes, cutoff frequency and dominant mode, Intrinsic Impedance, Power transmission and attenuation:- conductor loss and dielectric loss and Rectangular cavity resonator and its resonant frequency.

**UNIT – IV (12 Hours)**

**Antenna:** Concept of retarded potentials, Radiation Mechanism, types of antennas, power radiated by Hertzian dipole and its radiation resistance, qualitative analysis of half-wave dipole and quarter-wave monopole antenna, Antenna characteristics, Radiation Pattern, Beamwidth, Bandwidth, Radiation Intensity, Directive Gain, Directivity, Power Gain, Radiation Efficiency, Input Impedance, Effective Area and the Friis Transmission Equation.

**Practical component (if any) – Transmission Lines, Antenna and Wave Propagation**
***(MATLAB/SCILAB /Any other softwares)***

**Learning outcomes**

The Learning Outcomes of this course are as follows:

- Understand the phasor and its graphical representation for electromagnetic fields.
- Learn reflection and transmission of plane electromagnetic wave.
- Represent graphically various parameters of transmission line.
- Plot field configuration for different modes of the waveguide.
- Understand the radiation pattern and other characteristics of an antenna.

## LIST OF PRACTICALS ( Total Practical Hours – 30 Hours)

1. Program to determine the phasor of forward propagating field
2. Program to determine the instantaneous field of a plane wave
3. Program to find the electric and magnetic fields of reflected and transmitted wave at the interface of different types of media
4. Program to find the characteristic impedance and the phase constant of a distortionless line
5. Program to find the power dissipated of the lossy transmission line
6. Program to find the total power transmitted through the lossless transmission line
7. Program to plot the field configuration for TE and TM modes in waveguide
8. Program to determine the operating range of frequency for TE10 mode of air filled rectangular waveguide
9. Program to determine Directivity, Bandwidth and Beamwidth of an antenna.
10. Program to plot the radiation pattern of a Hertzian dipole and calculate its radiation resistance.

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. M. N. O. Sadiku, Principles of Electromagnetics, Oxford University Press (2001)
2. Karl E. Longren, Sava V. Savov, Randy J. Jost., Fundamentals of Electromagnetics with MATLAB, PHI
3. J. A. Edminister, Electromagnetics, Schaum Series, Tata McGraw Hill (2006)
4. N. Narayan Rao, Elements of Engineering Electromagnetics, Pearson Education (2006)
5. G. S. N. Raju, Antennas and Propagation, Pearson Education (2001) Transmission Lines,

**Suggestive readings**

1. W. H. Hayt and J.A. Buck, Engineering Electromagnetics, Tata McGraw Hill (2006)
2. D. C. Cheng, Field and Wave Electromagnetics, Pearson Education (2001)

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

## COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY THE DEPARTMENT

## GENERIC ELECTIVES (GE-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 | | |
| Microcontroller Systems | 4 | 3 | - | 1 | Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices | Basic C language program-ming |

### Learning Objectives

The Learning Objectives of this course are as follows:

- Understand architecture of Microcontroller.
- Write assembly language / C programs for the microcontroller.
- Apply knowledge and demonstrate proficiency of designing hardware interfaces for memory and I/O.

### Learning outcomes

The Learning Outcomes of this course are as follows:

- Explain the concepts related to architecture of microcontrollers
- Demonstrate knowledge of the development tools for a microcontroller, and write assembly language code according to specifications
- Design systems for common applications like general I/O, counters, data acquisition etc.
- Interfacing the external devices to the controller according to the user requirements to create novel products and solutions for the real - time problems.

**SYLLABUS OF ELGE-6A** **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

**UNIT – I ( 11 Hours)**

**Introduction to microcontroller:** Introduction to Microcontroller based system, Difference between Microprocessor and Microcontroller, Classification of microcontrollers based on architecture and Instruction Set (Overview of Harvard architecture and Von Neumann architecture, RISC and CISC microcontrollers), Microcontroller Features - Brown out Detector, Watch Dog Timer.

**UNIT – II (12 Hours)**

**Architectural Overview of AVR Microcontroller:** Block diagram description of ATMEGA32, Pin Description of ATMEGA32, AVR status register, General Purpose Register File, X, Y & Z registers, Stack Pointer, System Clock and Clock Options in AVR, System Control and Reset, Sleep Modes, AVR ATmega32 Memories: Flash Program Memory, SRAM Data Memory, EEPROM Data Memory & I/O Memory.

**UNIT – III (11 Hours)**

**Instruction set of AVR Microcontroller:** Addressing modes, Instruction set of AVR microcontroller, Data transfer, Arithmetic, Logic and Compare, Rotate and Shift, Branch and Call instructions, Bit manipulation instructions, MCU Control Instructions, Simple programs in Assembly Language / C Language

**UNIT – IV (11 Hours)**

**AVR on-chip peripherals:** General purpose I/O Ports, AVR I/O Port Programming, Introduction to interrupts, External interrupts, 8 and 16-bit Timers, Timer programming.

**Practical component (if any) – Microprocessor System**
***(Hardware and AVR Studio/ Other suitable IDE)***

**Learning outcomes**

The Learning Outcomes of this course are as follows:

- Be proficient in use of IDE's for assembly/ C programming for the microcontroller.
- Interface various I/O devices to provide solutions to real-world problems.
- Prepare the technical report on the experiments carried.

**LIST OF PRACTICALS ( Total Practical Hours – 30 Hours)**

1. Program to transfer a block of data.

2. Program to find the sum/subtraction of two 8-bit numbers.
3. Program to find the sum of N 8-bit numbers.
4. Program to find multiplication/ Division of two 8-bit numbers.
5. Program to find smallest of N numbers
6. Program to find the square root of 8-bit number.
7. Program to sort the numbers in ascending/ descending order.
8. Flash LED at observable rate.
9. Interface Input Switches and output LEDs.
10. Interface 7 segment display.

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. Programming and Customizing the AVR Microcontroller, By Dhananjay Gadre, McGraw Hill Education

**Suggestive readings**

1. The AVR Microcontroller and Embedded Systems Using Assembly and C, By Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, Pearson Education.
2. AVR ATmega32 data sheet- ATMEL Corporation

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

## GENERIC ELECTIVES (GE-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 | | |
| Arduino/ Rpi App Development | 4 | 2 | - | 2 | Class XII passed with Maths/Applied Maths | Basic C language programming |

### Learning Objectives

This course introduces the student to the fundamental understanding of Arduino/Rpi processors. After completion of this course students should be well versed in programming the microcontroller. They should be able to use various sensors and make microcontroller respond to the external environment.

### Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic concepts of Arduino Uno / Raspberry Pi and the programming environments.
- Understand digital and analog ports of a microcontroller and their usage.
- Understand the working of various sensors and their application in robotics.
- Design different circuits and display their outputs using LCD and other indicator

### SYLLABUS OF ELGE-6B Total Hours- Theory: 30 Hours, Practicals: 60 Hours

**UNIT – I (8 Hours)**

**Basic functionality of the Arduino/ Rpi board and its processor, Setting and configuring the board:** Pin diagram of Arduino/Rpi development board, Integrated Development Environment (IDE), IDEs like AVR Studio, WIN AVR, ARM 11, Installing and configuring for Robot programming, In System Programmer (ISP), loading programs on Robot, Differentiating Arduino board from Rpi board.

**UNIT – II (8 Hours)**

**Introduction of Embedded C Programming and programming concepts for Arduino/ LINUX for Rpi, Digital Ports:** Data Read and Write, Interfacing LEDs, Buzzer, Switches, 7 segment displays, LED dot matrix, Traffic lights, Introduction to 2 x 16 Characters LCD, Basic LCD control, Displaying message on LCD.

**UNIT – III (6 Hours)**

**Sensors:** IR range sensor of different range, Analog IR proximity sensors, Ultrasound scanner, LDR, Gyroscope and Accelerometer, Magnetometer, GPS receiver.

**UNIT – IV (8 Hours)**

**Communication with Arduino/ Raspberry Pi :** Wired RS232 (serial) Communication, Wireless ZigBee Communication, USB Communication, Simplex infrared Communication (IR remote to robot), Reading and writing to SD card.

**Practical component (if any) – Arduino/Rpi App Development**
***(Supporting IDE)***

## Learning outcomes

The Learning Outcomes of this course are as follows:

- Familiarize with the Arduino/Rpi microcontroller development boards.
- Understand interfacing of various display devices viz. 7-segment display, LED dot matrix, LCD.
- Understand various sensors, their applications and designing control experiments using

## LIST OF PRACTICALS ( Total Practical Hours- 60 Hours)

1. To blink an LED/interface a Buzzer using a digital pin of the processor.
2. To display binary count on LEDs using digital port of the processor.
3. To display decimal count on a 7-segment display.
4. To read data from a digital port of the processor and then display it on other digital port.
5. To print a message on LCD.
6. To display different patterns on LED dot matrix.
7. To read the voltage of a potentiometer using analog port of the processor and depict the variation on LEDs/LCD.
8. To interface IR proximity sensor to determine if some obstacle is nearby.
9. To interface Ultrasonic sensor to determine if some object is in the facing direction.
10. To interface LDR and display if its dark or bright on 7 segment/LCD.
11. To design a Traffic Light System
12. To design a Voice Control Home Automation
13. To design a PWM based variable system
14. To design a wireless appliance controlling system.

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 twelve.

**Essential/recommended readings**

1. Michal Mc Roberts "Beginning Arduino" Second Edition, Technology in Action
2. Massimo Banzi, "Getting started with Arduino" 2nd Edition, Orelly 2011
3. Richard Blum, " Arduino Programming in 24 Hours", Pearson Education, 1st edition, 2015.

**Suggestive readings**

1. Simon Monk, "Raspberry Pi Cookbook: Software and Hardware Problems and Solutions", O'Reilly Reprints; Second edition 2016

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