MAULANA ABUL KALAM AZAD
UNIVERSITY OF TECHNOLOGY,
WEST BENGAL

THE DEPARTMENT OF
MICROELECTRONICS AND VLSI TECHNOLOGY

SYLLABUS

FOR UNDER GRADUATE DEGREE COURSE (B.Tech)

IN

Electronics Engineering (VLSI Design and Technology)

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Electronics Engineering (VLSI Design and Technology)

(Applicable from the academic session 2023-2024)

VISION OF THE UNIVERSITY

To achieve the status of a globally ranked premier University in the field of Science, Technology, Pharmacy, Architecture, Management and interdisciplinary areas for the creation of high-caliber professionals with environmental consciousness, social, moral and ethical values along with the competency to face the new challenges of rapid technological advancements.

MISSION OF THE UNIVERSITY

To impart quality and value-based teaching & learning of international standard for solving the real life problems

- To create and disseminate knowledge both nationally & internationally towards the transformations of the civilization into a knowledge-based society
- To institutionalize the extension and field outreach activities with a view to transform the university system into an active instrument for social change
- To develop liaison and collaboration with the globally recognized academic institutions in order to inject new and fresh thinking in teaching, learning and research
- To generate intellectually capable and imaginatively gifted professionals and successful entrepreneurs having environmental consciousness and ethics who can work as individual or in group in multi-cultural global environments for continuing significantly towards the betterment of quality of human life.

Vision of Department of Microelectronics and VLSI Technology

The Department of Microelectronics and VLSI Technology envisions being a leader in pursuit of knowledge and wisdom for the holistic development of the rapid technological advancements of society in multi-disciplinary areas through excellence in teaching, training, and research and aspires to meet the global and socio-economic challenges of the state as well as country.

Mission statements of the Department of Microelectronics and VLSI Technology (MS)

The Department of Microelectronics and VLSI Technology motivates

MS-1: To participate in the Special Man Power Development Program to meet the ever-challenging issues in the field of Microelectronics and VLSI Technology

MS-2: To enable the students to formulate, design, and solve problems in applied science and engineering.

MS-3: To provide excellent teaching and research environment using state-of-the-art facilities.

MS-4: To provide adequate support in developing knowledge-based skills to meet the requirements of the Microelectronics, Embedded Systems, & VLSI industry.

MS-5: To develop a positive attitude among students to participate in collaborative research work

Program Educational Objectives (PEOs)

PEO-1: To Gain the ability to analyse, design, and implement VLSI Systems. Learn to apply modern skills, techniques, and engineering tools to create VLSI Devices, Circuits and Systems.

PEO-2: To understand the state of the art in the recent areas of research and to formulate problems from them and perform original work to contribute in the advancement of Microelectronics and VLSI Technology.
PEO-3: To learn different process steps involved in the fabrication of ICs.
PEO-4: To offer training on full cycle development of Device design and its fabrication using Electronic Design Automation (EDA) tool.
PEO-5: To train students in analytical reasoning, experimental skills and attitude to collaborate between inter-disciplinary research groups.

Mapping Program Educational Objectives (PEOs) with Mission Statements (MS)

	MS-1	MS-2	MS-3	MS-4	MS-5
PEO-1	3	3	3	3	1
PEO-2	3	3	3	3	1
PEO-3	2	3	3	3	2
PEO-4	2	2	3	3	1
PEO-5	2	3	2	2	2

Note: '3' in the box for high-level mapping, 2 for Medium-level mapping, and 1 for 'Low-level' mapping.

Program Outcomes (POs)

Engineering Graduates will be able to acquire:

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences.

PO3. Design/Development of Solutions: Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations.

PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.

PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and Sustainability: Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments.

PO12. Life - Long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

B. Tech. in **Electronics Engineering (VLSI Design and Technology)**, students will be able to:

PSO-1: Achieve conceptual knowledge-based skill to meet the man-power demand of upcoming semiconductor IC Design & Fabrication Industry.

PSO-2: Apply the knowledge in analysing the cutting-edge problems of Electronics, VLSI Device and Technology for their implementation in future integrated circuits.

PSO-3: Acquire professional and intellectual integrity and ethics of research for the requirement of sustaining in the advance Academics or Industry.

Mapping of Program Outcomes (POs) and Program Specific Outcomes (PSOs) with Program Educational Objectives (PEOs)

	PEO-1	PEO-2	PEO-3	PEO-4	PEO-5
PO-1	3	3	3	2	3
PO-2	1	3	2	2	3
PO-3	2	2	2	1	2
PO-4	3	3	2	3	3
PO-5	2	3	3	3	2
PO-6	2	2	2	2	3
PSO-1	3	3	2	3	3
PSO-2	2	3	3	3	2
PSO-3	2	2	2	2	3

Note: '3' in the box for 'high-level'mapping, 2 for 'Medium-level'mapping, 1 for 'Low-level' mapping.

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Course code and definition

Course code	Definitions
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC-CS	Professional core courses
PEC -CS	Professional Elective courses
OEC-CS	Open Elective courses
LC	Laboratory course
XC	PROJECT WORK, SEMINAR

Semester-wise Course Schedule:

Semester I

Sr. No.	Course Category	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
	3 WEEKS COMPULSORY INDUCTION PROGRAM (UHV-I)						
1	BSC	UGEVT101	Physics (Introduction to Electromagnetic Theory)	3	1	0	3
2	BSC	UGEVT191	Physics Laboratory (Introduction to Electromagnetic Theory Lab)	0	0	2	2
3	BSC	UGEVT102	Mathematics-I	3	1	0	4
4	ESC	UGEVT103	Basic Electrical Engineering	2	1	0	2
5	ESC	UGEVT192	Basic Electrical Engineering Lab	0	0	2	2
6	ESC	UGEVT121	Engineering Graphics & Design	1	0	0	1
7	ESC	UGEVT181	Engineering Graphics & Design Lab	0	0	4	2
8	HSMC	UGEVT104	English for Technical Writing	2	0	0	2
9	HSMC	UGEVT182	English for Technical Writing Lab	0	0	2	1
10	ESC	UGEVT183	Design Thinking	0	0	2	1
11	Audit Course	UGEVT184^	IDEA Lab Workshop	2	0	4	0
	TOTAL			**13**	**3**	**16**	**20**

Semester II

Sr. No.	Course Category	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC	UGEVT201	Chemistry	3	0	0	2
2	BSC	UGEVT291	Chemistry Laboratory	0	0	2	2
3	ESC	UGEVT202	Mathematics-II	3	1	0	4
4	ESC	UGEVT203	Programming for Problem Solving	2	0	0	2

5	ESC	UGEVT292	Programming for Problem Solving Laboratory	0	0	4	2
6	BSC	UGEVT204	Biology for Engineers	3	0	0	3
7	ESC	UGEVT293	Digital Fabrication / Workshop/Manufacturing Practices	0	0	4	2
8	HSMC	UGEVT205	Universal Human Values	2	1	0	3
9	Audit Course	UGEVT206^	Sports and Yoga or NSS/NCC	2	0	0	0
TOTAL				**15**	**2**	**10**	**20**

^ represent “Audit Course”.

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SEMESTER-III

Sr. No.	Course Category	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	PCC-CS	UGEVT301	Electronic Devices	3	0	0	3
2	PCC-CS	UGEVT391	Electronic Devices Lab	0	0	2	1
3	PCC-CS	UGEVT302	Digital System Design	3	0	0	3
4	PCC-CS	UGEVT392	Digital System Design Lab	0	0	2	1
5	PCC-CS	UGEVT303	Signals and Systems	3	0	0	3
6	PCC-CS	UGEVT304	Network Theory	3	0	0	3
7	PCC-CS	UGEVT305	Probability Theory and Stochastic Processes	3	1	0	4
8	BSC	UGEVT306	Physics of Semeconductor Devices*	3	0	0	3
9	Audit Course	UGEVT307	Personality Development through Life Enlightenment Skills (Audit Course)	2	0	0	0
TOTAL							**21**

SEMESTER-IV

Sr. No.	Course Category	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	PCC-CS	UGEVT401	Analog Circuits	3	0	0	3
2	PCC-CS	UGEVT491	Analog Circuits Lab	0	0	2	1
3	PCC-CS	UGEVT402	Microcontrollers and Computer Architecture	3	0	0	3
4	PCC-CS	UGEVT492	Microcontrollers Lab	0	0	2	1
5	PCC-CS	UGEVT403	Analog and Digital Communication	3	0	0	3
6	PCC-CS	UGEVT404	Introduction to Microfabrication	3	0	0	3
7	PCC-CS	UGEVT493	Introduction to Microfabrication Lab { Foundry Familiarization workshop / MOOC virtual lab}	0	0	2	1
8	PCC-CS	UGEVT405	Introduction to VLSI lifecycle	1	0	0	1
9	XC	UGEVT481	Micro Project	0	0	4	2
10	ESC	UGEVT406	Numerical Techniques	2	0	2	3
11	HMSC	UGEVT407	Finance & Accounting	3	0	0	3
9	Audit Course	UGEVT408	Pedagogy Studies (Audit Course)	2	0	0	0
TOTAL							**24**

*Extra paper

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SEMESTER-V

Sr. No.	Course Category	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	PCC-CS	UGEVT501	Digital Signal Processing	3	1	0	4
2	PCC-CS	UGEVT502	Electromagnetic Waves	3	1	0	4
3	PCC-CS	UGEVT591	Electromagnetic Waves Lab	0	0	2	1
4	PCC-CS	UGEVT503	VLSI Design	3	0	0	3
5	PCC-CS	UGEVT592	VLSI Design Lab	0	0	2	1
6	PCC-CS	UGEVT504	Control Systems	3	0	0	3
7	PCC-CS	UGEVT505	Embedded Systems	3	0	0	3
8	PCC-CS	UGEVT593	Embedded Systems Lab	0	0	2	1
9	HMSC	UGEVT506	Humanities – I	3	0	0	3
10	Audit Course	UGEVT507	Constitution of India (Audit Course)	2	0	0	0
TOTAL							**23**

SEMESTER-VI

Sr. No.	Course Category	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	PCC-CS	UGEVT601	VLSI Verification and Testing	3	0	0	3
2	PCC-CS	UGEVT691	VLSI Verification and Testing Lab	0	0	2	1
3	PCC-CS	UGEVT602	Semiconductor Equipment Design and Technology	3	0	0	3
4	PCC-CS	UGEVT603	Semiconductor Materials Synthesis and Characterization	3	0	0	3
5	PEC -CS	UGEVT604 (PE1)	a. Analog IC Design b. Semiconductor Device Modeling c. Introduction to MEMS	3	0	0	3
6	OEC-CS	UGEVT605 (OE1)	a. Quantum Computing b. Cyber Security	3	0	0	3
7	XC	UGEVT681	Mini Project	0	0	6	3
TOTAL							**19**

*Extra paper

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SEMESTER-VII

Sr. No.	Course Category	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	PEC -CS	UGEVT701 (PE2)	a. Low Power VLSI b. Nanoelectronics	3	0	0	3
2	PEC -CS	UGEVT702 (PE3)	a. Artificial Intelligence and Machine Learning b. Internet of Things c. Flexible Electronics**	3	0	0	3
3	OEC-CS	UGEVT703 (OE2)	a. Mixed Signal Design b. RF Microelectronics c. Semiconductor Packaging and Testing	3	0	0	3
4	OEC-CS	UGEVT704 (OE3)	a. Power Converters Design b. Digital Image Processing c. Algorithms for VLSI*	3	0	0	3
5	HMSC	UGEVT705	Humanities – II	3	0	0	3
6	XC	UGEVT781	Seminar	0	0	2	1
7	XC	UGEVT782	Internship /Project Phase -1	0	0	4	2
			TOTAL				**18**

SEMESTER-VIII

Sr. No.	Course Category	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	PEC -CS	UGEVT801 (PE4)	a. CAD for VLSI b. High Speed Interfacing Circuits c. Heterojunction Device Physics	3	0	0	3
2	OEC-CS	UGEVT802 (OE4)	a. Semiconductor Optoelectronics b. Bio-Medical Electronics c. Organic Electronics	3	0	0	3
3	XC	UGEVT881	Project	0	0	20	10
			TOTAL				**16**

***Extra Paper, **from other Semester's PE**

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Detailed Syllabus

SEMESTER I

Course Code	:	UGEVT101
Course Title	:	Physics- I
Number of Credits	:	5 (L: 3, T: 1, P: 2)
Course Category	:	Basic Science Courses
Course Contents in Physics	:	i. Introduction to Electromagnetic Theory

Course Objectives: To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

1. Introduction to Electromagnetic Theory
Pre-requisites (if any): Mathematics course with vector calculus

Module I: Electrostatics in vacuum

Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction; Practical examples like Faraday's cage and coffee-ring effect; Boundary conditions of electric field and electrostatic potential; method of images; energy of a charge distribution and its expression in terms of electric field.

Module II: Electrostatics in a linear dielectric medium

Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric displacement; boundary conditions on displacement; Solving simple electrostatics problems in presence of dielectrics – Point charge at the centre of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.

Module III: Magnetostatics

Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities.

Module IV: Magnetostatics in a linear magnetic medium

Magnetization and associated bound currents; auxiliary magnetic field H; Boundary conditions on B and H. Solving for magnetic field due to simple magnets like a bar magnet; magnetic susceptibility and

ferromagnetic, paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

Module V: Faraday's law

Faraday's law in terms of EMF produced by changing magnetic flux; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic breaking and its applications; Differential form of Faraday's law expressing curl of electric field in terms of time-derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi-static approximation; energy stored in a magnetic field.

Module VI: Displacement current, Magnetic field due to time-dependent electric field and Maxwell's equations

Continuity equation for current densities; Modifying equation for the curl of magnetic field to satisfy continuity equation; displace current and magnetic field arising from time dependent electric field; calculating magnetic field due to changing electric fields in quasistatic approximation. Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Pointing vector with examples. Qualitative discussion of momentum in electromagnetic fields.

Module VII: Electromagnetic waves

The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization; relation between electric and magnetic fields of an electromagnetic wave; energy carried by electromagnetic waves and examples. Momentum carried by electromagnetic waves and resultant pressure. Reflection and transmission of electromagnetic waves from a non-conducting medium- vacuum interface for normal incidence.

Laboratory - Introduction to Electromagnetic Theory (UGEVT191)

Choice of experiments from the following:

- Experiments on electromagnetic induction and electromagnetic braking;
- LC circuit and LCR circuit;
- Resonance phenomena in LCR circuits;
- Magnetic field from Helmholtz coil;
- Measurement of Lorentz force in a vacuum tube.

TEXTBOOKS/REFERENCES:

1. **Physics (Introduction to Electromagnetic Theory) with Lab Manual, Khanna Book Publishing Company.**
2. David Griffiths, Introduction to Electrodynamics
3. Halliday and Resnick, Physics
4. W. Saslow, Electricity, magnetism and light

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Course Code	:	**UGEVT102**
Course Title	**:**	**Mathematics- I**
Number of Credits	**:**	**4 (L: 3, T: 1, P: 0)**
Course Category	**:**	**Basic Science Courses**

Course Objectives: The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

Course Contents:

Module 1: Basic Calculus: (6 hours)

Curvature, evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Module 2: Single-variable Calculus (Differentiation): (6 hours)

Rolle's Theorem, Mean value theorems and applications; Extreme values of functions; Linear approximation; Indeterminate forms and L'Hospital's rule.

Module 3: Sequences and series: (10 hours)

Limits of sequence of numbers, Calculation of limits, Infinite series; Tests for convergence; Power series, Taylor and Maclaurin series; Taylor theorem, convergence of Taylor series, error estimates.

Module 4: Multivariable Calculus (Differentiation): (8 hours)

Limit, continuity and partial derivatives, directional derivatives, gradient, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.

Module 5: **Multivariable Calculus (Integration):** (10 hours)

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Gradient, curl and divergence, Theorems of Green, Gauss and Stokes.

TEXTBOOKS/REFERENCES:

1. **Mathematics-I (Calculus & Linear Algebra), Khanna Book Publishing Co.**
2. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
3. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
4. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
5. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
6. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
7. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
8. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
9. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Note: The modules have been prepared keeping the following from the Textbooks/References in mind:
(1) Module 1: The relevant sections from Chapters 2, 6 and 11 of [3]. (2) Module 2: Sections 3.1, 3.2, 3.3, 3.7 & 6.6 of [1].
(3) Module 3: Sections 8.1-8.6, 8.8-8.10 of [1].
(4) Module 4: Sections 12.1-12.5, 12.7-12.9 of [1].
(1) Module 5: Sections 13.1 – 13.7, 14.1 – 14.8 of [1].

Course outcomes: The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate differentiation and integration. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

The students will learn

- To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
- The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
- The tool of power series and Fourier series for learning advanced Engineering Mathematics.
- To deal with functions of several variables that are essential in most branches of engineering.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

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Course Code	**:**	**UGEVT103**
Course Title	**:**	**Basic Electrical Engineering**
Number of Credits	**:**	**4 (L: 2, T: 1, P: 2)**
Course Category	**:**	**Engineering Science Courses**

Course Objective: The objective of this Course is to provide the students with an introductory and broad treatment of the field of Electrical Engineering.

Course Contents:

Module I: D. C. Circuits covering, Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields;

Module II: Single Phase A.C. Circuits covering, Generation of sinusoidal voltage- definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series- parallel circuits; Three Phase A.C. Circuits covering, Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method;

Module III: Transformers covering, Principle of operation and construction of single phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation; Synchronous Generators covering, Principle of operation; Types and constructional features; EMF equation;

Module IV: DC Machines covering, working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor;

Module V: Three Phase Induction Motors covering; Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.

Module VI: Sources of Electrical Power covering, Introduction to Wind, Solar, Fuel cell, Tidal, Geo-thermal, Hydroelectric, Thermal-steam, diesel, gas, nuclear power plants; Concept of cogeneration, and distributed generation;

TEXT/REFERENCS BOOKS:

1. **Basic Electrical Engineering, Khanna Book Publishing.**
2. Ritu Sahdev (2022), Basic Electrical Engineering, Khanna Book Publishing.
3. Nagrath I.J. and D. P. Kothari (2001), Basic Electrical Engineering, Tata McGraw Hill.
4. Hayt and Kimberly, Engineering Circuit Analysis, Tata McGraw Hill.
5. Kulshreshtha D.C. (2009), Basic Electrical Engineering, Tata McGraw Hill.
6. Rajendra Prasad (2009), Fundamentals of Electrical Engineering, Prentice Hall, India Hughes, E. 2005)

COURSE OUTCOMES:

The students will learn:

1. To explain strong basics of Electrical Engineering and practical implementation of Electrical fundamentals.
2. To identify different applications of commonly used electrical machinery.

Laboratory – Basic Electrical Engineering Lab (UGEVT192)

Practical implementation of Electrical fundamentals.

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Course Code	**:**	**UGEVT121**
Course Title	**:**	**Engineering Graphics & Design**
Number of Credit	**:**	**1 (L: 1, T: 0, P: 0)**
Course Category	**:**	**Engineering Science Courses**

COURSE OBJECTIVE(S):

The objective of this Course is to provide the basic knowledge about Engineering Drawing. Detailed concepts are given in projections, technical drawing, dimensioning and specifications, so useful for a student in preparing for an engineering career.

COURSE CONTENTS:

Traditional Engineering Graphics: Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Computer Graphics: Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modelling; Solid Modelling; Introduction to Building Information Modelling (BIM).

(Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory)

Module I: Introduction to Engineering Drawing

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;

Module II: Orthographic Projections

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

Module III: Projections of Regular Solids

Covering those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Module IV: Sections and Sectional Views of Right Angular Solids

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only).

Module V: Isometric Projections

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;

Module VI: Overview of Computer Graphics
Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids];

Module VII: Customisation & CAD Drawing
Consisting of set up of the drawing page and the printer, including scale settings, setting up of Modules and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

Module VIII: Annotations, layering & other functions
Covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer- aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

Module IX: Demonstration of a simple team design project that illustrates
Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Text/Reference Books:

1. Engineering Graphics & Design Khanna Book Publishing.
2. Jain, Maheshwari, Gautam (2021), Engineering Graphics & Design, Khanna Book Publishing.
3. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House.
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
5. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
6. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
7. (Corresponding set of) CAD Software Theory and User Manuals.

Laboratory – Engineering Graphics & Design Lab (UGEVT181)
Number of Credits: 2 (L: 0, T: 0, P: 4)
Practical implementation of Engineering Graphics & Design.

Course Outcomes:
All phases of manufacturing or construction require the conversion of new ideas and design concepts into the basic line language of graphics. Therefore, there are many areas (civil, mechanical, electrical, architectural and industrial) in which the skills of the CAD technicians play major roles in the design and development of new products or construction. Students prepare for actual work situations through practical training in a new state-of-the-art computer designed CAD laboratory using engineering software. This course is designed to address:

- to prepare you to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- to prepare you to communicate effectively
- to prepare you to use the techniques, skills, and modern engineering tools necessary for engineering practice

The students will learn:
- To describe engineering design and its place in society.
- To discuss the visual aspects of engineering design.
- To use engineering graphics standards.
- To illustrate solid modelling.
- To use computer-aided geometric design.
- To design creating working drawings.
- To inspect engineering communication.

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Course Code	**:**	**UGEVT104**
Course Title	**:**	**English for Technical Writing**
Number of Credits	**:**	**2 (L: 2, T: 0, P: 0)**
Course Category	**:**	**Humanities & Social Science Courses**

Course Objective:

- To provide learning environment to practice listening, speaking, reading and writing skills.
- To assist the students to carry on the tasks and activities through guided instructions and materials.
- To effectively integrate English language learning with employability skills and training.
- To provide hands-on experience through case-studies, mini-projects, group and individual presentations.

Course Content:

Module I: Vocabulary Building

1.1. The concept of Word Formation
1.2. Root words from foreign languages and their use in English
1.3. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
1.4. Synonyms, antonyms, and standard abbreviations.

Module II: Basic Writing Skills

1.1. Sentence Structures
1.2. Use of phrases and clauses in sentences
1.3. Importance of proper punctuation
1.4. Creating coherence
1.5. Organizing principles of paragraphs in documents
1.6. Techniques for writing precisely

Module III: Identifying Common Errors in Writing

1.1. Subject-verb agreement

1.2. Noun-pronoun agreement
1.3. Misplaced modifiers
1.4. Articles
1.5. Prepositions
1.6. Redundancies
1.7. Clichés

Module IV: Nature and Style of sensible Writing
1.1. Describing
1.2. Defining
1.3. Classifying
1.4. Providing examples or evidence
1.5. Writing introduction and conclusion

Module V: Writing Practices
1.1. Comprehension
1.2. Précis Writing
1.3. Essay Writing

Module VI: Oral Communication
(This Module involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

Text/Reference Books:

1. **English (with Lab Manual), Khanna Book Publishing Co.**
2. Effective Communication Skills. Kul Bhushan Kumar, Khanna Book Publishing, 2022.
3. Practical English Usage. Michael Swan. OUP. 1995.
4. Remedial English Grammar. F.T. Wood. Macmillan.2007
5. On Writing Well. William Zinsser. Harper Resource Book. 2001
6. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
7. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
8. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

Laboratory – English for Technical Writing Lab (UGEVT182)
Number of Credits: 1 (L: 0, T: 0, P: 2)
Practical implementation of English for Technical Writing.

Course Outcomes: The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

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Course Code	**:**	**UGEVT183**
Course Title	**:**	**Design Thinking**
Number of Credits	**:**	**1 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Engineering Science Courses**

COURSE OBJECTIVE(S):
The objective of this Course is to provide the new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products which useful for a student in preparing for an engineering career.

COURSE CONTENTS:

Unit 1: An Insight to Learning
Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting

Unit 2: Remembering Memory
Understanding the Memory process, Problems in retention, Memory enhancement techniques

Unit 3: Emotions: Experience & Expression
Understanding Emotions: Experience & Expression, Assessing Empathy, Application with Peers

Unit 4: Basics of Design Thinking
Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – **Empathize, Define, Ideate, Prototype, Test**

Unit 5: Being Ingenious & Fixing Problem
Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving

Unit 6: Process of Product Design
Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design,

Examples of best product designs and functions, **Assignment – Engineering Product Design**

Unit 7: Prototyping & Testing
What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, **Sample Example**, Test Group Marketing

Unit 8: Celebrating the Difference
Understanding Individual differences & Uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences

Unit 9: Design Thinking & Customer Centricity
Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design

Unit 10: Feedback, Re-Design & Re-Create
Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – **"Solving Practical Engineering Problem through Innovative Product Design & Creative Solution".**

Course Outcomes (CO):
Student will able to
1. Compare and classify the various learning styles and memory techniques and Apply them in their engineering education
2. Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products
3. Develop new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products
4. Propose real-time innovative engineering product designs and Choose appropriate frameworks, strategies, techniques during prototype development
5. Perceive individual differences and its impact on everyday decisions and further Create a better customer experience

Text/Reference Books:
1. E Balaguruswamy (2022), Developing Thinking Skills (The way to Success), Khanna Book Publishing Company.

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Course Code	**:**	**UGEVT184**

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Course Title	**:**	**IDEA Lab Workshop**
Number of Credits	**:**	**0 (L: 2, T: 0, P: 4)**
Course Category	**:**	**AU-101**
Prerequisites	**:**	**None**

Course Objectives:

1. To learn all the skills associated with the tools and inventory associated with the IDEA Lab.
2. Learn useful mechanical and electronic fabrication processes.
3. Learn necessary skills to build useful and standalone system/ project with enclosures.
4. Learn necessary skills to create print and electronic documentation for the system/project

Course Contents*:*

Unit #	Topics	
1	Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and GitHub. Basic 2D and 3D designing using CAD tools such as FreeCAD, Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT.	Introduction to basic hand tools - Tape measure, combination square, Vernier calliper, hammers, fasteners, wrenches, pliers, saws, tube cutter, chisels, vice and clamps, tapping and threading. Adhesives Introduction to Power tools: Power saws, band saw, jigsaw, angle grinder, belt sander, bench grinder, rotary tools. Various types of drill bits,

2	Familiarization and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output) Circuit prototyping using (a) breadboard, (b) Zero PCB (c) 'Manhattan' style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly	Mechanical cutting processes - 3-axis CNC routing, basic turning, milling, drilling and grinding operations, Laser cutting, Laser engraving etc. Basic welding and brazing and other joining techniques for assembly. Concept of Lab aboard a Box.
	and soldering using pick and place machines.	
3.	Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and charging	3D printing and prototyping technology – 3D printing using FDM, SLS and SLA. Basics of 3D scanning, point cloud data generation for reverse engineering. Prototyping using subtractive cutting processes. 2D and 3D Structures for prototype building using Laser cutter and CNC routers. Basics of IPR and patents; Accessing and utilizing patent information in IDEA Lab
4.	Discussion and implementation of a mini project.	

5.	Documentation of the mini project (Report and video).

Laboratory Activities:

S. No.	List of Lab activities and experiments
1.	Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2.	Machining of 3D geometry on soft material such as soft wood or modelling wax.
3.	3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
4.	2D profile cutting of press fit box/casing in acrylic (3 or 6 mm thickness)/cardboard, MDF (2 mm) board using laser cutter & engraver.
5.	2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6.	Familiarity and use of welding equipment.
7.	Familiarity and use of normal and wood lathe.
8.	Embedded programming using Arduino and/or Raspberry Pi.
9.	Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

Reference Books:

S. No.	Title
1.	Workshop / Manufacturing Practices (with Lab Manual), Khanna Book Publishing.
2.	All-in-One Electronics Simplified, A.K. Maini; 2021. ISBN-13: 978-9386173393, Khanna Book Publishing Company, New Delhi.
3.	Simplified Q&A - Data Science with Artificial Intelligence, Machine Learning and Deep Learning, Rajiv Chopra, ISBN: 978-9355380821, Khanna Book Publishing Company, New Delhi.

4.	3D Printing & Design, Dr. Sabrie Soloman, ISBN: 978-9386173768, Khanna Book Publishing Company, New Delhi.
5.	The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.
6.	The Total Inventors Manual (Popular Science): Transform Your Idea into a Top-Selling Product. Sean Michael Ragan (Author). Weldon Owen; 2017. ISBN-13: 978-1681881584.
7.	Make: Tools: How They Work and How to Use Them. Platt, Charles. Shroff/Maker Media. 2018. ISBN-13: 978-9352137374
8.	The Art of Electronics. 3rd edition. Paul Horowitz and Winfield Hill. Cambridge University Press. ISBN: 9780521809269
9.	Practical Electronics for Inventors. 4th edition. Paul Sherz and Simon Monk. McGraw Hill. ISBN-13: 978-1259587542
10.	Encyclopedia of Electronic Components (Volume 1, 2 and 3). Charles Platt. Shroff Publishers. ISBN-13: 978-9352131945, 978-9352131952, 978-9352133703
11.	Building Scientific Apparatus. 4th edition. John H. Moore, Christopher C. Davis, Michael A. Coplan and Sandra C. Greer. Cambridge University Press. ISBN-13: 978-0521878586
12.	Programming Arduino: Getting Started with Sketches. 2nd edition. Simon Monk. McGraw Hill. ISBN-13: 978-1259641633
13.	Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards. Simon Monk and Duncan Amos. McGraw Hill Education. ISBN-13 : 978-1260019193.

14.	Pro GIT. 2nd edition. Scott Chacon and Ben Straub. A press. ISBN-13 : 978-1484200773
15.	Venuvinod, PK., MA. W., Rapid Prototyping – Laser Based and Other Technologies, Kluwer.
16.	Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010
17.	Chapman W.A.J, “Workshop Technology”, Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.

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SEMESTER II

Course Code	**:**	**UGEVT201**
Course Title	**:**	**Chemistry- I**
Number of Credits	**:**	**4 (L: 3, T: 0, P: 2)**
Course Category	**:**	**Basic Science Course**

Course Objective:

The objective of the Chemistry I is to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during course of their study in the industry and Engineering field. The student with the knowledge of the basic chemistry, will understand and explain scientifically the various chemistry related problems in the industry/engineering field. The student will able to understand the new developments and breakthroughs efficiently in engineering and technology. The introduction of the latest (R&D oriented) topics will make the engineering student upgraded with the new technologies.

Course Content:

Module I: Atomic and Molecular Structure

Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Module II: Spectroscopic techniques and applications

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering.

Module III: Intermolecular forces and potential energy surfaces

Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

Module IV: Use of free energy in chemical equilibria (6 lectures)

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

Module V: Periodic properties

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.

Module VI: Stereochemistry

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds.

Module VII: Organic reactions and synthesis of a drug molecule

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

LABORATORY (UGEVT291)

Choice of 10-12 experiments from the following:

1. Determination of surface tension and viscosity.
2. Thin layer chromatography.
3. Ion exchange column for removal of hardness of water.
4. Determination of chloride content of water.
5. Colligative properties using freezing point depression.
6. Determination of the rate constant of a reaction.
7. Determination of cell constant and conductance of solutions.
8. Potentiometry - determination of redox potentials and emfs.
9. Synthesis of a polymer/drug.
10. Saponification/acid value of an oil.
11. Chemical analysis of a salt.
12. Lattice structures and packing of spheres.
13. Models of potential energy surfaces.
14. Chemical oscillations- Iodine clock reaction.

15. Determination of the partition coefficient of a substance between two immiscible liquids.
16. Adsorption of acetic acid by charcoal.
17. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

Text/Reference Books:

1. **Chemistry – I with Lab Manual, Khanna Book Publishing.**
2. Engineering Chemistry, by Manisha Agrawal.
3. University chemistry, by B. H. Mahan
4. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
5. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
6. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
7. Physical Chemistry, by P. W. Atkins
8. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Course Outcomes: The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand phenomena at nanometre levels, one has to base the description of all chemical processes at molecular levels. The course will enable the students:

- To analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
- To rationalise bulk properties and processes using thermodynamic considerations.
- To distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
- To rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
- To list major chemical reactions that are used in the synthesis of molecules.

Laboratory Outcomes: The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn:

- To estimate rate constants of reactions from concentration of reactants/products as a function of time.
- To measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc.
- To synthesize a small drug molecule and analyze a salt sample.

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Course Code	**:**	**UGEVT202**
Course Title	**:**	**Mathematics- II**
Number of Credits	**:**	**4 (L: 3, T: 1, P: 0)**
Course Category	**:**	**Basic Science Course**

Course Objective: Mathematics fundamental necessary to formulate, solve and analyze engineering problems.

Course Content:

Module 1: Matrices (10 hours)

Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem.

Module 2: First order ordinary differential equations: (6 hours)

Exact, linear and Bernoulli's equations. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Module 3: Ordinary differential equations of higher orders: (8 hours)

Second order linear differential equations with variable coefficients: Euler-Cauchy equations, solution by variation of parameters; Power series solutions: Legendre's equations and Legendre polynomials, Frobenius method, Bessel's equation and Bessel's functions of the first kind and their properties.

Module 4: Complex Variable – Differentiation: (8 hours):

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Module 5: Complex Variable – Integration: (8 hours):

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic

functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

TEXTBOOKS/REFERENCES:

1. **Mathematics-II (Calculus, Ordinary Differential Equations and Complex Variable), Khanna Book Publishing Co.**
2. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
3. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
4. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2006.
5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
6. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
7. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
8. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
9. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
10. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
11. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.
12. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
13. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Note: The modules have been prepared keeping the following from the Textbooks/References in mind: (1) Module 1: Sections 7.3-7.5, 7.7, 7.8, 8.1-8.4 of [1].
(2) Module 2: Sections 1.4, 1.5 of [1]; Section 5.1 of [2].
(3) Module 3: Sections 2.5, 2.6, 2.10, 5.1, 5.3, 5.4, 5.5 of [1].
(4) Module 4: Sections 13.3 – 13.7, 17.1 – 17.3 of [1].
(5) Module 5: Sections 14.1 – 14.4, 15.2 – 15.4, 16.1 – 16.4 of [1].

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COURSE OUTCOMES: The objective of this course is to familiarize the prospective engineers with techniques in matrices, ordinary differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

The students will learn:

- The essential tool of matrices and linear algebra in a comprehensive manner.
- The effective mathematical tools for the solutions of differential equations that model physical processes.
- The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.

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Course Code	**:**	**UGEVT203**
Course Title	**:**	**Programming for Problem Solving**
Number of Credits	**:**	**4 (L: 2, T: 0, P: 4)**
Course Category	**:**	**Engineering Science Courses**

Course Objectives:

1. To learn the fundamentals of computers.
2. To understand the various steps in program development.
3. To learn the syntax and semantics of C programming language.
4. To learn the usage of structured programming approach in solving problems.
5. To understated and formulate algorithm for programming script
6. To analyze the output based on the given input variables

Course Contents:

Module I: Introduction to Programming**;** Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)
Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples.
From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax

and Logical Errors in compilation, object and executable code.

Module II: Arithmetic expressions and precedence.

Module III: Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops.

Module IV: Arrays, Arrays (1-D, 2-D), Character arrays and Strings

Module V: Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Module VI: Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference

Module VII: Recursion, Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Module VIII: Structures, Defining structures and Array of Structures

Module IX: Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

Module X: File handling (only if time is available, otherwise should be done as part of the lab).

PRACTICALS: (UGEVT292)

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

TEXT/REFERENCE BOOKS:

1. **Programming for Problem Solving, Khanna Book Publishing Co.**
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.

4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

COURSE OUTCOMES: The student will learn following through lectures:

- To formulate simple algorithms for arithmetic and logical problems.
- To translate the algorithms to programs (in C language).
- To test and execute the programs and correct syntax and logical errors.
- To implement conditional branching, iteration and recursion.
- To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
- To use arrays, pointers and structures to formulate algorithms and programs.
- To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
- To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

The student will learn following through Practicals:

- To formulate the algorithms for simple problems.
- To translate given algorithms to a working and correct program.
- To be able to correct syntax errors as reported by the compilers.
- To be able to identify and correct logical errors encountered at run time.
- To be able to write iterative as well as recursive programs.
- To be able to represent data in arrays, strings and structures and manipulate them through a program.
- To be able to declare pointers of different types and use them in defining self-referential structures.
- To be able to create, read and write to and from simple text files.

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UGEVT204	Biology (Biology for Engineers)	2L:1T:0P	3 credits

Module 1. Introduction

Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry

Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18^{th} Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These

examples will highlight the fundamental importance of observations in any scientific inquiry.

Module 2. Classification

Purpose: To convey that classification per se is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted.
Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitata- acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus

Module 3 -Genetics

Purpose: To convey that "Genetics is to biology what Newton's laws are to Physical Sciences" Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

Module 4.-Biomolecules

Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine
Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids

Module 5. Enzymes

Purpose: To convey that without catalysis life would not have existed on earth
Enzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyze reactions. Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

Module 6. Information Transfer

Purpose: The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code.

Define gene in terms of complementation and recombination. DICOM Image formats, The DNA Technology (Use and Application) Regulation Bill, 2019

Module 7. Macromolecular analysis

Purpose: How to analyses biological processes at the reductionistic level

Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

Module 8.- Metabolism

Purpose: The fundamental principles of energy transactions are the same in physical and biological world.

Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO2
+ H2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO2 and H2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge

Module 9. Microbiology

Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.

References:

1) General Biology, Uma Devi Koduru, Khanna Book Publishing Company.
2) Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
3) Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons
4) Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
5) Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
6) Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

Course Outcomes

After studying the course, the student will be able to:

- Describe how biological observations of 18th Century that lead to major discoveries.
- Convey that classification *per se* is not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological
- Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
- Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine
- Classify enzymes and distinguish between different mechanisms of enzyme action.
- Identify DNA as a genetic material in the molecular basis of information transfer.
- Analyse biological processes at the reductionistic level
- Apply thermodynamic principles to biological systems.
- Identify and classify microorganisms

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Course Code	**:**	**UGEVT293**
Course Title	**:**	**Digital Fabrication / Workshop/Manufacturing Practices**
Number of Credits	**:**	**2 (L: 0, T: 0, P: 4)**
Course Category	**:**	**Engineering Science Courses**

UGEVT293	**Digital Fabrication**	**0L:0T:4P**	**2 credits**

Course Objective:

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

Course Content:

1. **3D Printing (Additive Manufacturing)**

Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.

2. CAD for Additive Manufacturing

CAD Data formats, Data translation, Data loss, STL format.

5. Additive Manufacturing Techniques

3.1 Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.
3.2 Process, Process parameter, Process Selection for various applications.
3.3 Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools

4. Materials

4.1 Polymers, Metals, Non-Metals, Ceramics
4.2 Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties.
4.3 Support Materials

5. Additive Manufacturing Equipment

5.1 Process Equipment- Design and process parameters
5.2 Governing Bonding Mechanism
5.3 Common faults and troubleshooting
5.4 Process Design

6. Post Processing: Requirement and Techniques

7. Product Quality

7.1 Inspection and testing
7.2 Defects and their causes

LIST OF PRACTICALS

1. 3D Modelling of a single component.
2. Assembly of CAD modelled Components
3. Exercise on CAD Data Exchange.
6. Generation of .stl files.
7. Identification of a product for Additive Manufacturing and its AM process plan.
8. Printing of identified product on an available AM machine.
9. Post processing of additively manufactured product.
10. Inspection and defect analysis of the additively manufactured product.
11. Comparison of Additively manufactured product with conventional manufactured counterpart.

Text/Reference Books:

1. **Workshop / Manufacturing Practices (with Lab Manual), Khanna Book Publishing Co.**
2. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
3. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
4. Sabrie Soloman, "3D Printing and Design", Khanna Publishing House, Delhi.
5. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.
6. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science, 2013.
7. L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.
8. Zhiqiang Fan And Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy", InTech, 2012.

Course Outcomes:

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

1. Develop CAD models for 3D printing.
2. Import and Export CAD data and generate. stl file.
3. Select a specific material for the given application.
4. Select a 3D printing process for an application.
5. Produce a product using 3D Printing or Additive Manufacturing (AM).

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UGEVT293	**Workshop/Manufacturing Practices**	**0L:0T:4P**	**2 credits**

Course Objective:

1. To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.
2. To have a study and hands-on-exercise on plumbing and carpentry components.
3. To have a practice on gas welding, foundry operations and fitting
4. To have a study on measurement of electrical quantities, energy and resistance to earth.
5. To have a practice on soldering.

Course Content:

Module I: Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.
Module II: CNC machining, Additive manufacturing.
Module III: Fitting operations & power tools.
Module IV: Electrical & Electronics.
Module V: Carpentry.
Module VI: Plastic moulding, glass cutting.
Module VII: Metal casting.
Module VIII: Welding (arc welding & gas welding), brazing.

Practicals:

1. Machine shop
2. Fitting shop
3. Carpentry
4. Electrical & Electronics
5. Welding shop (Arc welding + Gas welding)
6. Casting
7. Smithy
8. Plastic moulding & Glass Cutting

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Suggested Text/Reference Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai**.**
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.
4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

Course Outcomes: Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

Laboratory Outcomes:

Upon completion of this laboratory course, students will be able:

- To fabricate components with their own hands.
- To relate practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
- To design small devices of their interest by assembling different components.

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UGEVT205	**Universal Human Values-II: Understanding Harmony And Ethical Human Conduct**	**2L:1T:0P**	**3 Credits**

Pre-requisites: None. Universal Human Values 1 (Desirable)

1- COURSES ON HUMAN VALUES

During the Induction Program, students would get an initial exposure to human values through Universal Human Values-I. This exposure is to be augmented by this compulsory full semester foundation course.

Objectives of UHV-II Course

This introductory course input is intended:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.

2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Thus, this course is intended to provide a much-needed orientational input in value education to the young enquiring minds.

Salient Features of the Course

The salient features of this course are:

1. It presents a universal approach to value education by developing the right understanding of reality (i.e. a worldview of the reality "as it is") through the process of self-exploration.
2. The whole course is presented in the form of a dialogue whereby a set of proposals about various aspects of the reality are presented and the students are encouraged to self-explore the proposals by verifying them on the basis of their natural acceptance within oneself and validate experientially in living.
3. The prime focus throughout the course is toward affecting a qualitative transformation in the life of the student rather than just a transfer of information.
4. While introducing the holistic worldview and its implications, a critical appraisal of the prevailing notions is also made to enable the students discern the difference on their own right.

Course Methodology

1. The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
2. The course is in the form of 28 lectures (discussions) and 14 practice sessions.
3. It is free from any dogma or value prescriptions.
4. It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation – the whole existence is the lab and every activity is a source of reflection.
5. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous self- evolution.
6. This self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs.

2- COURSE TOPICS

The course has 28 lectures and 14 tutorials in 5 modules. The lectures and tutorials are of 01-hour duration.

Tutorial sessions are to be used to explore and practice what has been proposed during the lecture sessions.
The Teacher's Manual provides the outline for lectures as well as practice sessions. The teacher is expected to present the issues to be discussed as propositions and encourage the students to have a dialogue.
The syllabus for the lectures and practice sessions is given below:

Module 1 – Introduction to Value Education (6 lectures and 3 tutorials for practice session)

Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
Lecture 2: Understanding Value Education
Tutorial 1: **Practice Session PS1** Sharing about Oneself
Lecture 3: Self-exploration as the Process for Value Education
Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations
Tutorial 2: Practice Session PS2 Exploring Human Consciousness
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfill the Basic Human Aspirations
Tutorial 3: Practice Session PS3 Exploring Natural Acceptance

Expected outcome:
The students start exploring themselves: get comfortable with each other and with the teacher; they start appreciating the need and relevance for the course.
The students start finding that technical education without study of human values can generate more problems than solutions. They also start feeling that lack of understanding of human values is the root cause of most of the present-day problems; and a sustained solution could emerge only through understanding of value-based living. Any solution brought out through fear, temptation of dogma will not be sustainable.

The students are able to see that verification on the basic of natural acceptance and experiential validation through living is the only way to verify right or wrong, and referring to any external source like text or instrument or any other person cannot enable them to verify with authenticity; it will only develop assumptions.
The students are able to see that their practice in living is not in harmony with their natural acceptance most of the time, and all they need to do is to refer to their natural acceptance to overcome this disharmony.
The students are able to see that lack of right understanding leading to lack of relationship is the major cause of problems in their family and not the lack of physical facility in most of the cases, while they have given higher priority to earning of physical facility in their life giving less value to or even ignoring relationships and not being aware that right understanding is the most important requirement for any human being.

Module 2 – Harmony in the Human Being (6 lectures and 3 tutorials for practice session) Lecture 7: Understanding Human being as the Co-existence of the Self and

the Body **Lecture 8:** Distinguishing between the Needs of the Self and the Body
Tutorial 4: Practice Session PS4 Exploring the difference of Needs of Self and Body
Lecture 9: The Body as an Instrument of the Self
Lecture 10: Understanding Harmony in the Self
Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the Self
Lecture 11: Harmony of the Self with the Body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session PS6 Exploring Harmony of Self with the Body

Expected outcome:

The students are able to see that they can enlist their desires and the desires are not vague. Also they are able to relate their desires to 'I' and 'Body' distinctly. If any desire appears related to both, they are able to see that the feeling is related to I while the physical facility is related to the body. They are also able to see that 'I' and Body are two realities, and most of their desires are related to 'I' and not body, while their efforts are mostly centered on the fulfilment of the needs of the body assuming that it will meet the needs of 'I' too.
The students are able to see that all physical facility they are required for a limited time in a limited quantity. Also, they are able to see that in case of feelings, they want continuity of the naturally acceptable feelings and they do not want feelings which are not naturally acceptable even for a single moment.
The students are able to see that activities like understanding, desire, though and selection are the activities of 'I' only the activities like breathing, palpitation of different parts of the body are fully the activities of the body with the acceptance of 'I' while the activities they do with their sense organs like hearing through ears, seeing through eyes, sensing through touch, tasting through tongue and smelling through nose or the activities they do with their work organs like hands, legs etc. are such activities that require the participation of both 'I' and body.
The students become aware of their activities of 'I' and start finding their focus of attention at different moments. Also they are able to see that most of their desires are coming from outside (through preconditioning or sensation) and are not based on their natural acceptance

The students are able to list down activities related to proper upkeep of the body and practice them in their daily routine. They are also able to appreciate the plants wildly growing in and around the campus which can be beneficial in curing different diseases.

Module 3 – Harmony in the Family and Society (6 lectures and 3 tutorials for practice session) Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction
Lecture 14: 'Trust' – the Foundational Value in Relationship
Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust
Lecture 15: 'Respect' – as the Right Evaluation
Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect
Lecture 16: Other Feelings, Justice in Human-to-Human

Relationship **Lecture 17:** Understanding Harmony in the Society
Lecture 18: Vision for the Universal Human Order
Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal

Expected outcome:

The students are able to note that the natural acceptance (intention) is always for living in harmony, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention as a result we conclude that I am a good person and other is a bad person.
The students are able to see that respect is right evaluation, and only right evaluation leads to fulfilment in relationship. Many present problems in the society are an outcome of differentiation (lack of understanding of respect), like gender biasness, generation gap, caste conflicts, class struggle, dominations through power play, communal violence, clash of isms and so on so forth. All these problems can be solved by realizing that the other is like me as he has the same natural acceptance, potential and program to ensure a happy and prosperous life for them and for others through he may have different body, physical facility or beliefs.
The students are able to use their creativity for education children. The students are able to see that they can play a role in providing value education for children. They are able to put in simple words the issues that are essential to understand for children and comprehensible to them. The students are able to develop an outline of holistic model for social science and compare it with the existing model.

Module 4 – Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)

Lecture 19: Understanding Harmony in the Nature
Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature
Lecture 21: Realizing Existence as Co-existence at All Levels
Lecture 22: The Holistic Perception of Harmony in Existence
Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence

Expected outcome:

The students are able to differentiate between the characteristics and activities of different orders and study the mutual fulfilment among them. They are also able to see that human being s are not fulfilling to other orders today and need to take appropriate steps to ensure right participation (in terms of nurturing, protection and right utilization) in the nature.
The students feel confident that they can understand the whole existence; nothing is a mystery in this existence. They are also able to see the interconnectedness in the nature, and point out how different courses of study relate

to the different units and levels. Also, they are able to make out how these courses can be made appropriate and holistic.

Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)

Lecture 23: Natural Acceptance of Human Values

Lecture 24: Definitiveness of (Ethical) Human Conduct

Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct

Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order

Lecture 26: Competence in Professional Ethics

Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education

Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies

Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

Expected outcome:

The students are able to present sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them.

The students are able to grasp the right utilization of their knowledge in their streams of Technology/Engineering/Management/any other area of study to ensure mutual fulfilment. E.g. mutually enriching production system with rest of nature.

The students are able to sincerely evaluate the course and share with their friends. They are also able to suggest measures to make the course more effective and relevant. They are also able to make use of their understanding in the course for the happy and prosperous family and society.

Guidelines and Content for Practice Sessions (Tutorials)

In order to connect the content of the proposals with practice (living), 14 practice sessions have been designed. The full set of practice sessions is available in the Teacher's Manual as well as the website.

Practice Sessions for Module 1 – Introduction to Value Education

PS1 Sharing about Oneself

PS2 Exploring Human Consciousness

PS3 Exploring Natural Acceptance

Practice Sessions for Module 2 – Harmony in the Human Being PS4
Exploring the difference of Needs of Self and Body
PS5 Exploring Sources of Imagination in the Self
PS6 Exploring Harmony of Self with the Body

Practice Sessions for Module 3 – Harmony in the Family and Society PS7
Exploring the Feeling of Trust
PS8 Exploring the Feeling of Respect
PS9 Exploring Systems to fulfil Human Goal

Practice Sessions for Module 4 – Harmony in the Nature (Existence) PS10
Exploring the Four Orders of Nature
PS11 Exploring Co-existence in Existence

Practice Sessions for Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics
PS12 Exploring Ethical Human Conduct
PS13 Exploring Humanistic Models in Education
PS14 Exploring Steps of Transition towards Universal Human Order

As an example, PS 7 is a practice session in module 3 regarding trust. It is explained below:

PS 7: Form small groups in the class and in that group initiate dialogue and ask the eight questions related to trust. The eight questions are:

1a. Do I want to make myself happy?	1b. Am I able to make myself always happy?
2a. Do I want to make the other happy?	2b. Am I able to make the other always happy?
3a. Does the other want to make him happy?	3b. Is the other able to make him always happy?
4a. Does the other want to make me happy?	4b. Is the other able to make me always happy?
Intention (Natural Acceptance)	Competence
What is the answer?	What is the answer?

Let each student answer the questions for himself/herself and everyone else. Discuss the difference between intention and competence. Observe whether you evaluate your intention and competence as well as the others' intention and competence.

Expected outcome of PS 7: The students are able to see that the first four questions are related to our Natural Acceptance i.e. intention and the next four to our Competence. They are able to note that the intention is always correct, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention, as a result we conclude

that I am a good person and other is a bad person.

3- READINGS:

3-1-Text Book and Teachers Manual

a. The Textbook - A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1

b. The Teacher's Manual- Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53

c. Professional Ethics and Human Values, Premvir Kapoor, ISBN: 978-93-86173-652, Khanna Book Publishing Company, New Delhi, 2022.

3-2-Reference Books

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

4- MODE OF CONDUCT (L-T-P-C 2-1-0-3)

Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.
Tutorial hours are to be used for practice sessions.

While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up" ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department.

Teacher preparation with a minimum exposure to at least one 8-day Faculty Development Program on Universal Human Values is deemed essential.

5- SUGGESTED ASSESSMENT:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation.

Example:

Assessment by faculty mentor: 10 marks
Self-assessment: 10 marks
Assessment by peers: 10 marks
Socially relevant project/Group Activities/Assignments: 20 marks
Semester End Examination: 50 marks
The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

6- OUTCOME OF THE COURSE:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in

this direction.

Therefore, the course and further follow up is expected to positively impact common graduate attributes like:

1. Holistic vision of life
2. Socially responsible behaviour
3. Environmentally responsible work
4. Ethical human conduct
5. Having Competence and Capabilities for Maintaining Health and Hygiene
6. Appreciation and aspiration for excellence (merit) and gratitude for all

This is only an introductory foundational input. It would be desirable to follow it up by

a) Faculty-student or mentor-mentee programs throughout their time with the institution

b) Higher level courses on human values in every aspect of living.

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Course Code	**:**	**UGEVT206**
Course Title	**:**	**Sports and Yoga**
Number of Credits	**:**	**0 (L: 2^, T: 0, P: 0)**
Course Category	**:**	**AU**

Course Objective(s):

- To make the students understand the importance of sound health and fitness principles as they relate to better health.
- To expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness.
- To create a safe, progressive, methodical and efficient activity based plan to enhance improvement and minimize risk of injury.
- To develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.

Course Contents:

Module I: Introduction to Physical Education

- Meaning & definition of Physical Education
- Aims & Objectives of Physical Education
- Changing trends in Physical Education

Module II: Olympic Movement

- Ancient & Modern Olympics (Summer & Winter)
- Olympic Symbols, Ideals, Objectives & Values
- Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanchand Award, Rajiv Gandhi Khel Ratna Award etc.)

Module III: Physical Fitness, Wellness & Lifestyle

- Meaning & Importance of Physical Fitness & Wellness
- Components of Physical fitness
- Components of Health related fitness
- Components of wellness
- Preventing Health Threats through Lifestyle Change
- Concept of Positive Lifestyle

Module IV: Fundamentals of Anatomy & Physiology in Physical Education, Sports and Yoga

- Define Anatomy, Physiology & Its Importance
- Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)

Module V: Kinesiology, Biomechanics & Sports

- Meaning & Importance of Kinesiology & Biomechanics in Physical Edu. & Sports
- Newton's Law of Motion & its application in sports.
- Friction and its effects in Sports.

Module VI: Postures

- Meaning and Concept of Postures.
- Causes of Bad Posture.
- Advantages & disadvantages of weight training.

- Concept & advantages of Correct Posture.
- Common Postural Deformities – Knock Knee; Flat Foot; Round Shoulders; Lordosis, Kyphosis, Bow Legs and Scoliosis.
- Corrective Measures for Postural Deformities

Module VII: Yoga

- Meaning & Importance of Yoga
- Elements of Yoga
- Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas
- Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana & Shashankasana)
- Relaxation Techniques for improving concentration - Yog-nidra

Module VIII: Yoga & Lifestyle

- Asanas as preventive measures.
- Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana.
- Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana.
- Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana.
- Diabetes: Procedure, Benefits & contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, Ardh Matsyendrasana.
- Asthema: Procedure, Benefits & contraindications for Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.

Module IX: Training and Planning in Sports

- Meaning of Training
- Warming up and limbering down
- Skill, Technique & Style
- Meaning and Objectives of Planning.
- Tournament – Knock-Out, League/Round Robin & Combination.

Module X: Psychology & Sports

- Definition & Importance of Psychology in Physical Edu. & Sports
- Define & Differentiate Between Growth & Development
- Adolescent Problems & Their Management

- Emotion: Concept, Type & Controlling of emotions
- Meaning, Concept & Types of Aggressions in Sports.
- Psychological benefits of exercise.
- Anxiety & Fear and its effects on Sports Performance.
- Motivation, its type & techniques.
- Understanding Stress & Coping Strategies.

Module XI: Doping

- Meaning and Concept of Doping
- Prohibited Substances & Methods
- Side Effects of Prohibited Substances

Module XII: Sports Medicine

- First Aid – Definition, Aims & Objectives.
- Sports injuries: Classification, Causes & Prevention.
- Management of Injuries: Soft Tissue Injuries and Bone & Joint Injuries

Module XIII: Sports / Games

Following subtopics related to any one Game/Sport of choice of student out of:
Athletics, Badminton, Basketball, Chess, Cricket, Kabaddi, Lawn Tennis, Swimming, Table Tennis, Volleyball, Yoga etc.

- History of the Game/Sport.
- Latest General Rules of the Game/Sport.
- Specifications of Play Fields and Related Sports Equipment.
- Important Tournaments and Venues.
- Sports Personalities.
- Proper Sports Gear and its Importance.

Text Books/References:

1. Modern Trends and Physical Education by Prof. Ajmer Singh.
2. Light On Yoga By B.K.S. Iyengar.
3. Health and Physical Education – NCERT (11th and 12th Classes)

Course Outcomes: On successful completion of the course the students will be able:

1. To practice Physical activities and Hatha Yoga focusing on yoga for strength, flexibility, and relaxation.
2. To learn techniques for increasing concentration and decreasing anxiety which leads to stronger academic performance.

3. To learn breathing exercises and healthy fitness activities
4. To understand basic skills associated with yoga and physical activities including strength and flexibility, balance and coordination.
5. To perform yoga movements in various combination and forms.
6. To assess current personal fitness levels.
7. To identify opportModuleies for participation in yoga and sports activities.
8. To develop understanding of health-related fitness components: cardiorespiratory endurance, flexibility and body composition etc.
9. To improve personal fitness through participation in sports and yogic activities.
10. To develop understanding of psychological problems associated with the age and lifestyle.
11. To demonstrate an understanding of sound nutritional practices as related to health and physical performance.
12. To assess yoga activities in terms of fitness value.
13. To identify and apply injury prevention principles related to yoga and physical fitness activities.
14. To understand and correctly apply biomechanical and physiological principles elated to exercise and training.

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SEMESTER III

UGEVT301	**Electronic Devices**	**3L:0T:0P**	**3 credits**

Course Contents:

Introduction to Semiconductor Physics: Review of Quantum Mechanics, Electrons in periodic Lattices, E-k diagrams. Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current,

mobility and resistivity; sheet resistance, design of resistors

Generation and recombination of carriers; Poisson and continuity equation P-N junction characteristics, I-V characteristics, and small signal switching models; Avalanche breakdown, Zener diode, Schottky diode

Bipolar Junction Transistor, I-V characteristics, Ebers-Moll Model, MOS capacitor, C-V characteristics, MOSFET, I-V characteristics, and small signal models of MOS transistor, LED, photodiode and solar cell;

Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography, etching, chemical vapor deposition, sputtering, twin-tub CMOS process.

NPTEL Reference: https://nptel.ac.in/courses/117106091 Text

/Reference Books:

1. G. Streetman, and S. K. Banerjee, ―Solid State Electronic Devices,‖ 7th edition, Pearson,2014.
2. D. Neamen , D. Biswas "Semiconductor Physics and Devices," McGraw-Hill Education
3. S. M. Sze and K. N. Kwok, ―Physics of Semiconductor Devices,‖ 3rd edition, John Wiley &Sons, 2006.
4. C.T. Sah, ―Fundamentals of solid state electronics,‖ World Scientific Publishing Co. Inc, 1991.
5. Y. Tsividis and M. Colin, ―Operation and Modeling of the MOS Transistor,‖ Oxford Univ.Press, 2011.
6. A.K. Maini, N. Maini, All-in-One Electronics Simplified, Khanna Book Publishing, New Delhi, 2021.
7. A.K. Maini, Analog Electronics, Khanna Book Publishing, New Delhi, 2022.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the principles of semiconductor Physics
2. Understand and utilize the mathematical models of semiconductor junctions and MOS transistors for circuits and systems.

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UGEVT391: Electronic Devices Lab (0L:0T:2P) (1 credit)

Hands-on experiments related to the course contents of **UGEVT301**

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UGEVT302	**Digital System Design**	**3L:0T:0P**	**3 credits**

Course Contents:

Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De Morgan'sTheorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, CodeConversion.

MSI devices like Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU.

Sequential Logic Design: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Rippleand Synchronous counters, Shift registers, Finite state machines, Design of synchronous FSM,Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, PseudoRandom Binary Sequence generator, Clock generation

Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory elements, Conceptof Programmable logic devices like FPGA. Logic implementation using Programmable Devices.

VLSI Design flow: Design entry: Schematic, FSM & HDL, different modeling styles in VHDL, Data typesand objects, Dataflow, Behavioral and Structural Modeling, Synthesis and Simulation
VHDL constructs and codes for combinational and sequential circuits.

Text/Reference Books:

1. M.Morris Mano and Michel.D.Ciletti, Digital Design with an introduction to HDL, VHDL and Verilog, Sixth edition Pearson education
2. R. Anand, Digital System Design Using VHDL, Khanna Book Publishing Company.
3. R. Anand, Digital Electronics, Khanna Book Publishing Company.
4. R.P. Jain, ―Modern digital Electronics‖, Tata McGraw Hill, 4th edition, 2009.
5. Douglas Perry, ―VHDL‖, Tata McGraw Hill, 4th edition, 2002.
6. W.H. Gothmann, ―Digital Electronics- An introduction to theory and practice‖, PHI, 2nd edition ,2006.
7. D.V. Hall, ―Digital Circuits and Systems‖, Tata McGraw Hill, 1989
8. Charles Roth, ―Digital System Design using VHDL‖, Tata McGraw Hill 2nd edition 2012.

Course outcomes:

At the end of this course students will demonstrate the ability to

1. Design and analyze combinational logic circuits
2. Design & analyze modular combinational circuits with MUX/DEMUX, Decoder, Encoder
3. Design & analyze synchronous sequential logic circuits

4. Use HDL & appropriate EDA tools for digital logic design and simulation

UGEVT392: Digital System Design Laboratory [0L: 0T: 2P] (1 credit)

Hands-on experiments related to the course contents UGEVT302

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UGEVT303	**Signals and Systems**	**3L:0T:0P**	**3 credits**

Course Contents:

Signals and systems as seen in everyday life, and in various branches of engineering and science.

Energy and power signals, continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.

Linear shift-invariant (LSI) systems, impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs. Characterization of causality and stability of linear shift- invariant systems. System representation through differential equations and difference equations.

Periodic and semi-periodic inputs to an LSI system, the notion of a frequency response and its relation to the impulse response, Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem.The idea of signal space and orthogonal bases,

The Laplace Transform, notion of eigen functions of LSI systems, a basis of eigen functions, region of convergence, poles and zeros of system, Laplace domain analysis, solution to differential equations and system behavior.

The z-Transform for discrete time signals and systems- eigen functions, region of convergence, z- domain analysis.

State-space analysis and multi-input, multi-output representation. The state-transition matrix and its role. The Sampling Theorem and its implications- Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems.

Text/Reference books:

1. R. Anand, Signals and Systems, Khanna Publishing House, 2019.
2. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall, 1983.
3. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete",

4th edition, Prentice Hall, 1998.
4. Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, c1998.
5. Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems", John Wiley and Sons, 1995.

Course outcomes:

At the end of this course students will demonstrate the ability to

1. Analyze different types of signals
2. Represent continuous and discrete systems in time and frequency domain using different transforms
3. Investigate whether the system is stable
4. Sampling and reconstruction of a signal

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UGEVT304	**Network Theory**	**3L:0T:0P**	**3 credits**

Course Contents:

Node and Mesh Analysis, matrix approach of network containing voltage and current sources, and reactances, source transformation and duality. Network theorems: Superposition, reciprocity, Thevenin‘s, Norton‘s, Maximum power Transfer, compensation and Tallegen's theorem as applied to AC. circuits. Trigonometric and exponential Fourier series: Discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs, power factor, effective values, Fourier transform and continuous spectra, three phase unbalanced circuit and power calculation.

Laplace transforms and properties: Partial fractions, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions.

Transient behavior, concept of complex frequency, Driving points and transfer functions poles and zeros of admittance function, their properties, sinusoidal response from pole-zero locations, convolution theorem and Two four port network and interconnections, Behaviors of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters.

Text/Reference Books:

1. Van, Valkenburg.; ―Network analysis‖; Prentice hall of India, 2000
2. Sudhakar, A., Shyammohan, S. P.; ―Circuits and Network‖; Tata McGraw-Hill New Delhi, 1994
3. A William Hayt, ―Engineering Circuit Analysis‖ 8th Edition, McGraw-Hill Education

4. Ashfaq Husain, Networks and Systems, Khanna Book Publishing, 2021.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand basics electrical circuits with nodal and mesh analysis.
2. Appreciate electrical network theorems.
3. Apply Laplace Transform for steady state and transient analysis.
4. Determine different network functions.
5. Appreciate the frequency domain techniques.

UGEVT305	**Probability and Stochastic Processes**	**3L:0T:0P**	**3 credits**

Course Contents:

Sets and set operations; Probability space; Conditional probability and Bayes theorem; Combinatorial probability and sampling models.

Discrete random variables, probability mass function, probability distribution function, example random variables and distributions; Continuous random variables, probability density function, probability distribution function, example distributions

Joint distributions, functions of one and two random variables, moments of random variables; Conditional distribution, densities and moments; Characteristic functions of a random variable; Markov, Chebyshev and Chernoff bounds;

Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, central limit theorem.

Random process. Stationary processes. Mean and covariance functions. Ergodicity. Transmission of random process through LTI. Power spectral density.

Text/Reference Books:

1. H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing," Third Edition, Pearson Education
2. A.Papoulis and S. Unnikrishnan Pillai, ``Probability, Random Variables and Stochastic Processes," Fourth Edition, McGraw Hill.
3. K. L. Chung, Introduction to Probability Theory with Stochastic Processes, Springer International
4. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability, UBS Publishers,

5. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Stochastic Processes, UBS Publishers
6. S. Ross, Introduction to Stochastic Models, Harcourt Asia, Academic Press.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand representation of random signals
2. Investigate characteristics of random processes
3. Make use of theorems related to random signals
4. To understand propagation of random signals in LTI systems.

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UGEVT306	Physics of Semeconductor Devices	3L:0T:0P	3 credits

Unit 1

Introduction: Unit cell, Bravais lattices, crystal systems, crystal planes and Miller indices, symmetry elements. Defects and imperfections – point defects, line defects, surface defects and volume defects.

Electrical conductivity: Classical free electron theory – assumptions, drift velocity, mobility and conductivity, drawbacks. quantum free electron theory – Fermi energy, Fermi factor, carrier concentration. Band theory of solids – origin of energy bands, effective mass, distinction between metals, insulators and semiconductors.

Unit 2

Theory of semiconductors: Intrinsic and extrinsic semiconductors, band structure of semiconductors, carrier concentration in intrinsic and extrinsic semiconductors, electrical conductivity and conduction mechanism in semiconductors, Fermi level in intrinsic and extrinsic semiconductors and its dependence on temperature and carrier concentration. Carrier generation – recombination, mobility, drift-diffusion current. Hall effect.

Theory of p-n junctions – diode and transistor: p-n junction under thermal equilibrium, forward bias, reverse bias, carrier density, current, electric field, barrier potential. V-I characteristics, junction capacitance and voltage breakdown.

Unit 3

Bipolar junction transistor, p-n-p and n-p-n transistors: principle and modes of operation, current relations. V-I characteristics. Fundamentals of MOSFET, JFET. Heterojunctions – quantum wells.

Semiconducting devices: Optical devices: optical absorption in a semiconductor, e- -hole generation. Solar cells – p-n junction, conversion efficiency, heterojunction solar cells. Photo detectors – photo conductors, photodiode, p-i-n diode. Light emitting diode (LED) – generation of light, internal and external quantum efficiency.

Modern semiconducting devices: CCD – introduction to nano devices, fundamentals of tunneling devices,

design considerations, physics of tunneling devices.

Text Books
C Kittel, "Introduction to Solid State Physics", Wiley, 7th Edn., 1995.
D A Neamen, "Semiconductor Physics and Devices", TMH, 3rd Edn., 2007.

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UGEVT307	**Personality Development through Life Enlightenment Skills (Audit Course)**	**2L:0T:0P**	**0 credit**

Course Objectives
1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in student s

Syllabus
Unit:1 Content Hours:8

Neetisatakam-Holistic development of personality
- Verses- 19,20,2 1,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)
- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

Unit:2 Content Hours:8

- Approach to day to day work and duties.
- Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

Unit:3 Content Hours:8
- Statements of basic knowledge.
- Shrimad Bhagwad Geeta: Chapter 2 - Verses 56, 62, 68
- Chapter 12 - Verses 13, 14, 15, 16,17, 18
- Personality of Role model. Shrimad Bhagwad Geeta: Chapter 2 - Verses 17, Chapter 3 - Verses 36,37,42,

- Chapter 4 - Verses 18, 38,39
- Chapter 18 - Verses 37,38,63

Suggested reading
1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P. Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes
Students will be able to
1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

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SEMESTER IV

UGEVT401	**Analog circuits**	**3L:0T:0P**	**3 credits**

Course Contents:

Diode Circuits, Amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Biasing schemes for BJT and FET amplifiers, bias stability, various frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers.

High frequency transistor models, frequency response of single stage andmultistage amplifiers, cascode amplifier. Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues. Feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin.

Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators(phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), non-sinusoidal oscillators.
Current mirror: Basic topology and its variants, V-I characteristics, outputresistance and minimum sustainable voltage (VON), maximum usable load. Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR. OP- AMP design: design of differential amplifier for a given specification, design of gain stages and output stages, compensation.

OP-AMP applications: review of inverting and non-inverting amplifiers, integratorand differentiator, summing amplifier, precision rectifier, Schmitt trigger and its applications. Active filters: Low pass, high pass, band

pass and band stop, design guidelines.

Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistorstring etc. Analog-to- digital converters (ADC): Single slope, dual slope, successive approximation, flash etc. Switched capacitor circuits: Basic concept, practical configurations, application in amplifier, integrator, ADC etc.

Text/Reference Books:

1. A.V.N. Tilak, Design of Analog Circuits, Khanna Publishing House, 2022.
2. A.S. Sedra and K.C. Smith, Microelectronic Circuits, sixth edition, Oxford University Press
3. J.V. Wait, L.P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, McGraw Hill, 1992.
4. J. Millman and A. Grabel, Microelectronics, 2nd edition, McGraw Hill, 1988.
5. P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press, 1989.
6. Paul R. Gray and Robert G.Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley, 3rd Edition

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the characteristics of diodes and transistors
2. Design and analyze various rectifier and amplifier circuits
3. Design sinusoidal and non-sinusoidal oscillators
4. Understand the functioning of OP-AMP and design OP-AMP based circuits
5. Design ADC and DAC

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UGEVT491	**Analog circuits lab**	**0L:0T:2P**	**1 credit**

Hands-on experiments related to the course contents UGEVT401

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UGEVT402	**Microcontrollers and Computer Architecture**	**3L:0T:0P**	**3 credits**

Course Contents:

Functional units of a computer, Von Neumann and Harvard computer architectures, CISC and RISC

architectures. Processor Architecture – General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers. Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute, timing response, instruction sequencing and execution. Algorithms for binary multiplication and division. Fixed and floating-point number representation.

Introduction to Microprocessor, Microprocessor architecture and its operations, Memory, Input & output devices, Logic devices for interfacing, The 8085 MPU, Example of an 8085 based computer, Memory interfacing. Basic interfacing concepts, interfacing output displays, Interfacing input devices, Memory mapped I/O,

Data Transfer operations, Arithmetic operations, Logic Operations, Branch operation, Addressing modes, Writing assembly language programs, Programming techniques: looping, counting and indexing. Additional data transfer and 16 bit arithmetic instruction, Arithmetic operations related to memory, Logic operation: rotate, compare, counter and time delays. Subroutines. Interrupts

8255 Programmable peripheral interface, interfacing keyboard and seven segment display, 8254 (8253) programmable interval timer, 8259A programmable interrupt controller, Direct Memory Access and 8237 DMA controller.

Microcontrollers and Embedded Processors. Architecture – Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts. Assembly Language Programming - Addressing Modes, Instruction set (Detailed study of 8051 instruction set is required).

Simple programming examples in assembly language. Interfacing with 8051 using Assembly language programming: LED, Seven segment LED display. Programming in C – Declaring variables, Simple examples – delay generation, port programming, code conversion. Interfacing of – LCD display, Keyboard, Stepper Motor, DAC and ADC -- with 8051 and its programming. 8051 Timers/Counters - Modes and Applications. Serial Data Transfer – SFRs of serial port, working, Programming the 8051 to transfer data serially.

Text/Reference Books:

1. Computer System Architecture, Mano M M , Prentice Hall India
2. 8085 Microprocessor Architecture, Applications and Programming, Ramesh S Gaonkar, Penram International
3. The 8051 microcontroller and Embedded systems, Muhammed Ali Mazidi & Janice Gill Mazidi, Pearson Education

Course Outcomes:

At the end of the course, the students will be able to

1. Explain the functional units with respect to computer architecture
2. Develop simple programmes using 8085/8051 assembly language
3. Interface 8085 with peripherals using assembly language
4. Interface 8051 with peripherals using assembly language/C

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UGEVT492	**Microcontrollers Lab**	**0L:0T:2P**	**1 credit**

Hands-on experiments related to the course contents UGEVT402

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UGEVT403	**Analog and Digital Communication**	**3L:0T:0P**	**3 credits**

Course Contents:

Review of signals and systems, Frequency domain representation of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.

Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De- emphasis, Threshold effect in angle modulation.

Pulse modulation. Sampling process. Pulse Amplitude and Pulse code modulation (PCM),Differential pulse code modulation. Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers.

Elements of Detection Theory, Optimum detection of signals in noise,Coherent communication with waveforms- Probability of Error evaluations. BasebandPulse Transmission- Inter symbol Interference and Nyquist criterion.Pass band Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying,Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying.

Digital Modulation tradeoffs. Optimum demodulation of digital signals over band-limited channels- Maximum likelihood sequence detection (Viterbi receiver). Equalization Techniques. Synchronization and Carrier Recovery for Digital modulation.

Text/Reference Books:

1. Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3. Taub H. and Schilling D.L., "Principles of Communication Systems‖, Tata McGraw Hill, 2001.
4. Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering",John Wiley, 1965.
5. Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication", Kluwer Academic Publishers, 2004.
6. Proakis J.G., ``Digital Communications", 4th Edition, McGraw Hill, 2000.
7. R. Anand, Communication Systems, Khanna Book Publishing Company, 2011.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Analyze and compare different analog modulation schemes for their efficiency and bandwidth
2. Analyze the behavior of a communication system in presence of noise
3. Investigate pulsed modulation system and analyze their system performance
4. Analyze different digital modulation schemes and can compute the bit error performance

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UGEVT404	**Introduction to Microfabrication**	**3L:0T:0P**	**3 credits**

Course Contents:

Introduction: History of IC's; Operation & Models for Devices of Interest: CMOS and MEMS. Electronic Materials: Crystal Structures, Defects in Crystals, Si, Poly Si, Si Crystal Growth. Clean room and Wafer Cleaning: Definition, Need of Clean Room, RCA cleaning of Si.

Oxidation: Dry and Wet Oxidation, Kinetics of Oxidation, Oxidation Rate Constants, Dopant Redistribution, Oxide Charges, Device Isolation, LOCOS, Oxidation System

Lithography: Overview of Lithography, Radiation Sources, Masks, Photoresist, Components of Photoresist Optical Aligners, Resolution, Depth of Focus, Advanced Lithography: E-beam Lithography, X-ray Lithography, Ion Beam Lithography.

Diffusion: Pre-Deposition and Drive-in Diffusion Modeling, Dose, 2-Step Diffusions, Successive Diffusion, Lateral Diffusion, Series Resistance, Junction Depth, Irvin's Curves, Diffusion System. Ion Implantation: Problems in Thermal Diffusion, Advantages of Ion Implantation, Applications in ICs, Ion Implantation System, Mask, Energy Loss Mechanisms, Depth Profile, Range & Straggle, Lateral Straggle, Dose, Junction Depth, Ion Implantation Damage, Post Implantation Annealing, Ion Channeling, Multi Energy Implantation

Thin Film Deposition: Physical Vapor Deposition: Thermal evaporation, Resistive Evaporation, Electron beam evaporation, Laser ablation, Sputtering Chemical Vapor Deposition: Advantages and disadvantages of Chemical Vapor deposition (CVD) techniques over PVD techniques, reaction types, Boundaries and Flow, Different kinds of CVD techniques: APCVD, LPCVD, Metalorganic CVD (MOCVD), Plasma Enhanced CVD etc.

Etching: Anisotropy, Selectivity, Wet Etching, Plasma Etching, Reactive Ion Etching.

Overview of Interconnects, Contacts, Metal gate/Poly Gate, Metallization, Problems in Aluminum Metal contacts, Al spike, Electromigration, Metal Silicides, Multi-Level Metallization, Planarization, Inter Metal Dielectric

Text/Reference Books:

1. Silicon VLSI Technology, Plummer, Deal and Griffin ,1st Edition, Pearson Education,2009
2. Fundamental of Semiconductor Fabrication, Sze and May,2nd Edition, Wiley India, 2009
3. Silicon Process Technology, S K Gandhi,2nd Edition, Wiley India,2009

Course Objectives:

At the end of this course students will demonstrate the ability to

1. Elucidate the CMOS process flow
2. Analyze various critical processing steps in microfabrication
3. Appreciate the advanced methods involved in IC fabrication.
4. Analyze the advancements in CMOS process fabrication with scaling in technology.

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UGEVT493	**Introduction to Microfabrication lab**	**0L:0T:2P**	**1 credit**

Hands-on experiments related to the course contents UGEVT404

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UGEVT405	**Introduction to VLSI Life Cycle**	**1L:0T:0P**	**1 credits**

Course Contents:

System & Architectural Design: Defining a system specification, performance analysis, cost analysis, identifying various functional blocks/modules; categorizing them in terms of digital, analog, RF and mixed signal blocks

Functional verification, logic design: Verifying the functionality of blocks, behavioral description, logic minimization, synthesis, verification and testing

Circuit Optimization and Physical Design: Optimization of synthesized blocks for various performance metric, Introduction to placement and route, Layout Vs Schematic (LVS) verification, Design for Manufacturability.

Tape Out: Post layout simulations, Process Voltage Testing, Process Design Kit, Design Rule Check, GDSII

Fabrication and Packaging: CMOS process flow, dicing, various types of packaging.

Text /Reference Books:

1. Sneh Saurabh, “Introduction to VLSI Design flow”, Cambridge University Press.
2. N. H. E. Weste and C. Harris, “Principles of CMOS VLSI Design: A System Perspective, 3rd Edition, Pearson Education 2007
3. M.Morris Mano and Michel.D.Ciletti, Digital Design with an introduction to HDL, VHDL and Verilog, Sixth edition Pearson education

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the intricacies in VLSI Design flow
2. Understand overall process of VLSI Design flow starting from system level all the way to the transistor level

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UGEVT481	**Micro Project**	**0L:0T:4P**	**2 credits**

✔ Project topics related to the Program B.Tech in Electronics Engineering (VLSI Design and Technology).

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UGEVT406	**Numerical Techniques**	**2L:0T:2P**	**3 credits**

Unit-I

Introduction: Numbers and their accuracy, Computer Arithmetic, Mathematical preliminaries, Errors and their Computation, General error formula, Error in a series approximation Solution of Algebraic and Transcendental Equation: Bisection Method, Iteration method, Method of false position, Newton-Raphson method, Methods of finding complex roots, Muller's method, Rate of convergence of Iterative methods, Polynomial Equations.

Unit-II

Interpolation: Finite Differences, Difference tables Polynomial Interpolation: Newton's forward and backward formula Central Difference Formulae: Gauss forward and backward formula, Stirling's, Bessel's, Everett's formula. Interpolation with unequal intervals: Langrange's Interpolation, Newton Divided difference formula, Hermite's Interpolation,

Unit-III

Numerical Integration and Differentiation: Introduction, Numerical differentiation Numerical Integration: Trapezoidal rule, Simpson's 1/3 and 3/8 rule, Boole's rule, Waddle's rule.

Unit-IV

Solution of differential Equations: Picard's Method, Euler's Method, Taylor's Method, Runge-Kutta Methods, Predictor Corrector Methods, Automatic Error Monitoring and Stability of solution.

Unit-V

Statistical Computation: Frequency chart, Curve fitting by method of least squares, fitting of straight lines, polynomials, exponential curves etc, Data fitting with Cubic splines, Regression Analysis, Linear and Non linear

Regression, Multiple regression, Statistical Quality Control methods.

References:

1. Rajaraman V, "Computer Oriented Numerical Methods", Pearson Education
2. Gerald & Whealey, "Applied Numerical Analyses", AW
3. Jain, Iyengar and Jain, "Numerical Methods for Scientific and Engineering Computations", New Age Int.
4. Grewal B S, "Numerical methods in Engineering and Science", Khanna Publishers, Delhi
5. T Veerarajan, T Ramachandran, "Theory and Problems in Numerical Methods, TMH
6. Pradip Niyogi, "Numerical Analysis and Algorithms", TMH
7. Francis Scheld, " Numerical Analysis", TMH
8. Sastry S. S, "Introductory Methods of Numerical Analysis", Pearson Education.
9. Gupta C.B., Vijay Gupta, "Introduction to Statistical Methods", Vikas Publishing.
10. Goyal, M, "Computer Based Numerical and Statistical Techniques", Firewall Media, New Delhi.

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UGEVT407	**Management-I (Organizational Behaviour)/ Finance & Accounting**	**3L:0T:0P**	**3 credits**

*Syllabus Available (in other B.Tech course of MAKAUT in-house)

UGEVT408	**Pedagogy Studies (Audit Course)**	**2L:0T:0P**	**0 credits**

Course Objectives: Students will be able to:

4. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
5. Identify critical evidence gaps to guide the development.

Syllabus

Units	Content	Hours
1	• Introduction and Methodology: • Aims and rationale, Policy background, Conceptual framework and terminology • Theories of learning, Curriculum, Teacher education. • Conceptual framework, Research questions. • Overview of methodology and Searching.	4
2	• Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. • Curriculum, Teacher education.	2

3	• Evidence on the effectiveness of pedagogical practices • Methodology for the in depth stage: quality assessment of included studies. • How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? • Theory of change. • Strength and nature of the body of evidence for effective pedagogical practices. • Pedagogic theory and pedagogical approaches. • Teachers' attitudes and beliefs and Pedagogic strategies.	4
4	• Professional development: alignment with classroom practices and follow-up support • Peer support • Support from the head teacher and the community. • Curriculum and assessment • Barriers to learning: limited resources and large class sizes	4
5	• Research gaps and future directions • Research design • Contexts • Pedagogy • Teacher education • Curriculum and assessment ● Dissemination and research impact.	2

Suggested reading

1. Ackers J,Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importa nce of evaluation, Journal of Curriculum Stud ies, *36* (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-si te teacher education research project (MUSTER) country report 1. London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (20 13) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, *33* (3): 272-282.
5. Alexander RJ (200 1) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blach-well.
6. Chavan M (2003) Read India: A mass scale, rapid, 1earning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

Course Outcomes:

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?

2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

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SEMESTER V

UGEVT501	**Digital Signal Processing**	**3L:0T:0P**	**3 credits**

Course Contents:

Discrete time signals: Sequences; representation of signals on orthogonal basis; Sampling and reconstruction of signals; Discrete systems attributes, Z-Transform, Analysis of LSI systems, frequency Analysis, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform Algorithm, Implementation of Discrete Time Systems

Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters.

Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multirate signal processing.
Application of DSP.

Text/Reference Books:

1. S.K.Mitra, Digital Signal Processing: A computer based approach.TMH
2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
3. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms And Applications, Prentice Hall, 1997.
4. L.R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall, 1992.
5. J.R. Johnson, Introduction to Digital Signal Processing, Prentice Hall, 1992.
6. D.J.DeFatta, J. G. Lucas andW.S.Hodgkiss, Digital Signal Processing, John Wiley& Sons, 1988.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Represent signals mathematically in continuous and discrete time and frequency domain
2. Get the response of an LSI system to different signals
3. Design of different types of digital filters for various applications

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UGEVT502	**Electromagnetic Waves**	**3L:0T:0P**	**3 credits**

Course Contents:

Transmission Lines- Equations of Voltage and Current on TX line, Propagation constant and characteristic impedance, and reflection coefficient and VSWR, Impedance Transformation on Loss- less and Low loss Transmission line, Power transfer on TX line, Smith Chart, Admittance Smith Chart, Applications of transmission lines: Impedance Matching, use transmission line sections as circuit elements.

Maxwell‘s Equations- Basics of Vectors, Vector calculus, Basic laws ofElectromagnetics, Maxwell's Equations, Boundary conditions at Media Interface.

Uniform Plane Wave- Uniform plane wave, Propagation of wave, Wavepolarization, Poincare‘s Sphere, Wave propagation in conducting medium, phase and group velocity, Power flow and Poynting vector, Surface current and power loss in a conductor

Plane Waves at a Media Interface- Plane wave in arbitrary direction, Reflection and refraction at dielectric interface, Total internal reflection, wave polarization at media interface, Reflection from a conducting boundary.

Wave propagation in parallel planewaveguide, Analysis of waveguide general approach, Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization, Attenuation in waveguide.

Radiation: Solution for potential function, Radiation from the Hertz dipole, Powerradiated by hertz dipole, Radiation Parameters of antenna, receiving antenna, Monopole and Dipole antenna,

Text/Reference Books:

1. R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill India, 2005
2. R.L. Yadav, Electromagnetic Fields and Waves, Khanna Book Publishing, 2021.
3. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, Prentice Hall, India
4. Narayana Rao, N: Engineering Electromagnetics, 3rd ed., Prentice Hall, 1997.
5. David Cheng, Electromagnetics, Prentice Hall

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand characteristics and wave propagation on high frequency transmission lines
2. Carryout impedance transformation on TL
3. Use sections of transmission line sections for realizing circuit elements
4. Characterize uniform plane wave
5. Calculate reflection and transmission of waves at media interface

6. Analyze wave propagation on metallic waveguides in modal form
7. Understand principle of radiation and radiation characteristics of an antenna

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UGEVT591	**Electromagnetic Waves lab**	**0L:0T:2P**	**1 credit**

Hands-on experiments related to the course contents UGEVT502

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UGEVT503	**VLSI Design**	**3L:0T:0P**	**3 credits**

Course Contents:

Overview of VLSI Design: Historical perspective, overview of VLSI design methodologies, VLSI design flow, design hierarchy, concepts of regularity, modularity, and locality, VLSI design styles, design quality, packaging technology, CAD technology.

MOS Transistor Theory: Introduction to The metal oxide semiconductor (MOS) structure, Long- channel I-V characteristics, C-V characteristics, non-linear I-V effects, DC transfer characteristics.

Introduction to ASIC and SoC, Overview of ASIC flow, functional verification, RTL-GATE level synthesis, synthesis optimization techniques, pre-layout timing verification, static timing analysis, floor-planning, placement and routing, extraction, post layout timing verification, extraction.

CMOS Process Technology: Fabrication process flow- basic steps, the CMOS n-Well process, layout design rules, stick diagram, full-custom mask layout design

MOS Inverter (Static Characteristics): Resistive-load inverter, inverter with n-type 16 MOSFET load, CMOS inverter

MOS Inverters (Switching Characteristics and Interconnects effects): Delay-time definitions, calculation of delay times, logical efforts, inverter design with delay constraints, estimation of interconnect parasitics, calculation of interconnect delay, Bus vs. Network-onChip (NoC), switching power dissipation of CMOS inverters.

Combination CMOS Logic Circuits: MOS logic circuits with depletion nMOS loads, CMOS logic circuits, complex logic circuits, CMOS transmission gates (pass gates), ratioed, dynamic and pass transistor logic circuits.

Sequential MOS logic circuits: Behaviour of bi-stable elements, SR latch circuits, clocked latch and flip-flop circuits, CMOS D-latch and edge-triggered flip-flop. Timing path, Setup time and hold time static, example of setup and hold time static, setup and hold slack, clock skew and jitter, Clock, reset and power distributions.

Semiconductor Memories: Memory Design, SRAM, DRAM structure and implementations

Recent Trends in VLSI Design & its research issues in industry: System case studies. Design automation of VLSI Systems: basic concepts. Deep Sub-micron Technologies: Some Design Issues

Text/Reference Books:

1. N. H. E. Weste and C. Harris, "Principles of CMOS VLSI Design: A System Perspective, 3rd Edition, Pearson Education 2007.
2. J. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits: A Design Perspective, 2nd Edition, Prentice Hall 2004.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. provide an overview of the digital IC design techniques
2. Understand the characteristics of CMOS inverter.
3. Analyze the static and dynamic characteristics of CMOS circuits
4. Design and implementation of combinational and sequential circuits
5. Evaluate the performance of CMOS circuits

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UGEVT592	**VLSI Design Lab**	**0L:0T:2P**	**1 credit**

Hands-on experiments related to the course contents UGEVT503.

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UGEVT504	**Control Systems**	**3L:0T:0P**	**3 credits**

Course Contents:

Introduction to control problem- Industrial Control examples. Transfer function. System with dead- time. System response. Control hardware and their models: potentiometers, synchros, LVDT, dc and ac servomotors, tacho-generators, electrohydraulic valves, hydraulic servomotors, electro pneumatic valves, pneumatic actuators. Closed-loop systems. Block diagram and signal flow graph analysis.

Feedback control systems- Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. proportional, integral and derivative systems. Feed-forward and multi- loop control configurations, stability concept, relative stability, Routh stability criterion.

Time response of second-order systems, steady-state errors and error constants. Performance specifications in time-domain. Root locus method of design. Lead and lag compensation.

Frequency-response analysis- Polar plots, Bode plot, stability in frequency domain, Nyquist plots.

Nyquist stability criterion. Performance specifications in frequency-domain. Frequency-domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag compensation. Op-amp based and digital implementation of compensators. Tuning of process controllers. State variable formulation and solution.

State variable Analysis- Concepts of state, state variable, state model, state modelsfor linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability.

Introduction to Optimal control & Nonlinear control, Optimal Control problem,Regulator problem, Output regulator, treking problem. Nonlinear system – Basic concept & analysis.

Text/Reference Books:

1. Gopal. M., ―Control Systems: Principles and Design, Tata McGraw-Hill, 1997.
2. Ambikapathy A., Control Systems, Khanna Book Publications, 2019.
3. Kuo, B.C., ―Automatic Control System‖, Prentice Hall, sixth edition, 1993.
4. Ogata, K., ―Modern Control Engineering‖, Prentice Hall, second edition, 1991.
5. Nagrath & Gopal, ―Modern Control Engineering‖, New Age International, New Delhi

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Characterize a system and find its study state behavior
2. Investigate stability of a system using different tests
3. Design various controllers
4. Solve linear, non-linear and optimal control problems

*****

UGEVT505	**Embedded Systems**	**3L:0T:0P**	**3 credits**

Course Contents:

Introduction to Embedded systems: Motivation based on applications of embedded systems, Basics of Embedded systems, functional block

Modeling of Embedded system: Mathematical modeling of physical systems to fit into embedded systems, Continuous Dynamics, Discrete Dynamics, Hybrid Systems, actor models, Composition of State Machines

Microcontrollers, Sensors, Actuators, Basics of Microcontrollers, 8951, Arduino microcontroller development board, I/Os, Sensors, Actuators

Interfacing between analog and digital blocks, signal conditioning, digital signal processing. sub- system interfacing, interfacing with external systems, user interfacing. Design tradeoffs due to process compatibility, thermal considerations, etc., Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.

Text/Reference Books:

1. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.
3. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
4. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
5. K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming, and Applications", Penram Intl, 1996.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Suggest design approach using advanced controllers to real-life situations.
2. Design interfacing of the systems with other data handling / processing systems.
3. Appreciate engineering constraints like energy dissipation, data exchange speeds etc.

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UGEVT593	**Embedded Systems lab**	**0L:0T:2P**	**1 credits**

Hands-on experiments related to the course contents UGEVT505

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UGEVT506	**Humanities – I**	**3L:0T:0P**	**3 credits**

*Syllabus Available (in other B.Tech course of MAKAUT in-house)

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UGEVT507	**Constitution of India (Audit Course)**	**2L:0T:0P**	**0 credits**

Course Objectives:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opm10n regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism In India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution .

Syllabus

Units	Content	Hours
1	**•History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working)	4
2	**•Philosophy of the Indian Constitution:** Preamble Salient Features	4
3	**•Contours of Constitutional Rights & Duties:** • Fundamental Rights • Right to Equ ality • Right to Freedom • Right against Exploitation • Right to Freedom of Religion • Cultural and Educational Rights • Right to Constitutional Remedies • Directive Principles of State Policy • Fundamental Duties.	4

4	**•Organs of Governance:** • Parliament • Composition • Qualifications and Disqualifications • Powers and Functions • Executive • President • Governor • Council of Ministers •Judiciary, Appointment and Transfer of Judges, Qualifications • Powers and Functions	4
5	**•Local Administration:** • District's Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of Elected Representative, CEC of Municipal Corporation. • Pachayati raj: Introduction, PRI: Zila Pachayat. • Elected officials and their roles, CEO Zila Pachayat: Position and role. • Block level: Organizational Hierarchy (Different departments), • Village level:Role of Elected and Appointed officials, • Importance of grass root democracy	4
6	**•Election Commission:** • Election Commission: Role and Functioning. • Chief Election Commissioner and Election Commissioners. • State Election Commission: Role and Fu nctioning. • Institute and Bodies for the welfare of SC/ ST/ OBC and women .	4

Suggested reading

1. The Constitution of India, 1950 (Bare Act), Government Publication .
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, lst Edition, 20 15.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

l. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

4. Discuss the passage of the Hindu Code Bill of 1956.

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SEMESTER VI

UGEVT601	**VLSI Verification and Testing**	**3L:0T:0P**	**3 credits**

Course Contents:

Physical faults and their modeling. Fault equivalence and dominance; fault collapsing, Fault simulation: parallel, deductive and concurrent techniques; critical path tracing.

Test generation for combinational circuits: Boolean difference, D-algorithm, Podem, random etc. Exhaustive, random and weighted test pattern generation; aliasing and its effect on fault coverage.

PLA testing: cross-point fault model, test generation, easily testable designs. Memory

testing: permanent, intermittent and pattern-sensitive faults; test generation.

Delay faults and hazards; test pattern generation techniques, ATPG and its different types

Test pattern generation for sequential circuits: ad-hoc and structures techniques scan path and LSSD, boundary scan

Built-in self-test techniques: LBIST and MBIST. Verification: logic level (combinational and sequential circuits), RTL-level (data path and control path). Verification of embedded systems. Use of formal techniques: decision diagrams, logic-based approaches.

ASIC/IP Verification, direct and random testing, Error detection and correction codes.

Text/Reference Books:

1. Essentials of Electronic Testing, M. L. Bushnell and V. D. Agrawal,3rd Kluwer Academic Publishers 2002
2. Delay Fault Testing for VLSI Circuits,A. Krstic and K-T Cheng,3rd Kluwer Academic Publishers. 2003
3. Testing of Digital Systems, N. K. Jha and S. Gupta, 2nd, Cambridge University Press. 2003
4. Digital Systems Testing and Testable Design, M. Abramovici, M. A. Breuer and A. D. Friedman, 3rd, Wiley-IEEE Press. 1994
5. Fault Tolerant and Fault Testable P. K. Lala, 4th, Hardware Design, Prentice-Hall.
6. All-in-One Electronics Simplified, A.K. Maini & Nakul Maini, Khanna Book Publishing.

Course Outcomes:

1. Extend knowledge of the requirement of fault modeling in VLSI circuits.

2. Generate test vectors to test a circuit efficiently covering maximum faults.
3. Demonstrate the concept of Memory testing techniques
4. Discuss about Built-in-Self Test and its application in modern digital design
5. Use modern tools for testing and verification.

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UGEVT691	**VLSI Verification and Testing lab**	**0L:0T:2P**	**1 credits**

Hands-on experiments related to the course contents UGEVT601.

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UGEVT602	**Semiconductor Equipment Design and Technology**	**3L:0T:0P**	**3 credits**

Course Contents:

Fundamentals of vacuum technology- nomenclature and definition, pressure regions, gas properties and laws, molecular processes and kinetic theory, gas flow calculations, technology of vacuum pumps-throughput, pumping speed, forevacuum and high vacuum pumping, pump system design, diaphragm pumps, vacuum blowers, diffusion pumps, cryogenic pumps, turbomolecular pumps, pumps for ultra-high vacuum, vacuum measurements, types of gauges, mass analysis and spectrometry, mass flow control and measurement, vacuum valves, flanges and components, vacuum feedthroughs, vacuum seals, vacuum leak detectors, vacuum chambers and viewports, outgassing, vacuum applications such as sputtering, plasma etching, CVD, epitaxy, electron spectroscopies

Plasma Science and Technology

Plasma physics- Motion of individual electrons and ions in electric and magnetic fields- Single, collisionless, particles in DC and AC electric fields, Particle orbits in magnetic fields, Space charge and collective effects, Debye shielding, Plasma oscillations and plasma frequency, Plasma shielding and plasma sheaths, Response to DC, RF and microwave fields, Plasma potential, Characteristic electron and ion transit times

Introduction to Plasma Reactors- Chamber pump systems, load locks, mass flow control, hazardouns gas handling, effluent control, Pressure gauges / control (Piranhi, thermocouple, ionization, baratron, convectron) Wafer chucks (Clamps/Electrostatic chucks)
RF and microwave power sources and coupling- Power sources, matching networks, feedthroughs and coupling
RF Capacitively and Inductively coupled plasmas- Spatial variations of plasma potential, electric field,

charge density and energy, optical emission, Sheaths at powered, grounded and floating surfaces, parameters, models, matching networks, Ion bombardment - energy / time / frequency/ power dependencies
Applications in processes- etching, deposition, sputtering, ashing

Text/Reference Books:

1. V.V. Rao, T.B. Ghosh, K.L. Chopra,, Vacuum Science and Technology, Allied Publishers Ltd., New Delhi
2. Handbook of Vacuum Science and Technology- Dorothy M. Hoffman, Bawa Singh, John H. Thomas, III, Academic Press
3. Handbook of Vacuum Technology: Karl Jousten, Wiley
4. Plasma Etching: Fundamentals and Applications: 7 (Series on Semiconductor Science and Technology)- M. Sugawara, OUP Oxford
5. Plasma Etching in Semiconductor Fabrication- Russ Morgan, Elsevier
6. Fundamentals of Plasma Physics- J. A. Bittencourt, Springer India
7. Plasma Physics and Engineering- Alexander Fridman, Lawrence Kennedy, CRC Press

Course Outcome:

1. Understand Basics of Vacuum Technology
2. Understand Basics of Plasma Technology
3. Ability to analyze vacuum and plasma based semiconductor equipment

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UGEVT603	**Semiconductor materials synthesis and characterization**	**3L:0T:0P**	**3 credits**

Course Contents:

Principles of extraction, pyrometallurgical processes, material and heat balance of processes, thermodynamics of processes; introduction to laws, thermodynamic equilibrium, thermochemistry, Ellingham diagram. Process kinetics; introduction to chemical kinetics and rate processes, heterogeneous kinetics, kinetics of liquid-liquid reactions, concepts of reactor design. Structure & properties of molten liquids.

Production of metallurgical grade (MG) Si: Carbothermic reduction, principle, operation and practice of sub-merged arc furnace, energy and process calculation, refining & impurities control in molten MG Si.Production of electronic grade (EG) Si: Concept of fluidized bed reactor, Siemens Process. Crystal Growth: Crystal growth processes (Bridgman and its variants, Czochralski), heat and species transfer during non-steady and steady state plane-front growth, interface instability and effect of convection on interface

stability

XRD (Bulk and thin film), Microscopy (Optical, SEM, TEM, SPM), UV-Visible spectroscopy, Photoluminescence, Raman spectroscopy

Text/Reference Books:

1. Principles of Extractive Metallurgy, Terkel Rosenqvist, McGraw-Hill Book Company, 1973
2. Stoichiometry and Thermodynamics of Metallurgical Processes: Y K Rao, Cambridge University Press, 2009
3. Handbook of Extractive Metallurgy: Fathi Habashi; Wiley-VCH , 1997
4. Solar-Grade Silicon: Refining and Recycling: L Zhang et al, CRC Press, 2013
5. Scheel and Capper: Crystal Growth Technology: From Fundamentals and Simulation to Large-scale Production, John Wiley & Sons, 2008
6. Nakajima and Usami: Crystal Growth of Si for Solar Cell, Springer, 2009
7. Essentials of Metallurgical Thermodynamics, R.H. Tupkary, Khanna Book Publishing, 2016.

Course Outcome:

1. Understand the Silicon extraction and purification process
2. Understand Crystallography of Si and various methods of growth
3. Understand key methods of physicochemical, morphological and analytical characterization techniques

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Appendix - 1

Program Elective Courses:

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Sr. No.	Course Code	Course Title	Preferred Semester	Hrs /Week L: T: P	Credits
1	**UGEVT601A**	Analog IC Design	VI	3:0:0	3
2	**UGEVT601B**	Semiconductor Device Modeling	VI	3:0:0	3
3	**UGEVT801A**	CAD for VLSI	VIII	3:0:0	3
4	**UGEVT802A**	Semiconductor Optoelectronics	VIII	3:0:0	3
5	**UGEVT601C**	Introduction to MEMS	VI	3:0:0	3
6	**UGEVT703C**	Semiconductor Packaging and Testing	VII	3:0:0	3
7	**UGEVT703A**	Mixed Signal Design	VII	3:0:0	3
8	**UGEVT802B**	Bio-Medical Electronics	VIII	3:0:0	3
9	**UGEVT703B**	RF Microelectronics	VII	3:0:0	3
10	**UGEVT704B**	Digital Image Processing	VII	3:0:0	3
11	**UGEVT701A**	Low Power VLSI	VII	3:0:0	3
12	**UGEVT801B**	High-Speed Interfacing Circuits	VIII	3:0:0	3
13	**UGEVT704A**	Power Converters Design	VII	3:0:0	3
14	**UGEVT802C**	Organic Electronics	VIII	3:0:0	3
15	**UGEVT702C**	Flexible Electronics	VIII	3:0:0	3
16	**UGEVT701B**	Nanoelectronics	VII	3:0:0	3
17	**UGEVT801C**	Heterojunction Device Physics	VIII	3:0:0	3

18	**UGEVT702B**	Internet of Things	VII	3:0:0	3
19	**UGEVT605B**	Cyber Security	VI	3:0:0	3
20	**UGEVT702A**	Artificial Intelligence and Machine Learning	VII	3:0:0	3
21	**UGEVT605A**	Quantum Computing	VI	3:0:0	3
22	**UGEVT704C**	Algorithms for VLSI	VII	3:0:0	3

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Electronics Engineering (VLSI Design and Technology)

(Applicable from the academic session 2023-2024)

UGEVT601A	**Analog IC Design**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Introduction to MOSFETS, Simple MOSFET circuits, Threshold voltage model, Capacitance model, Mobility model, MOSFET basics, Basic current mirrors, Cascode current mirrors, Active current mirrors with large and small signal analysis, MOSFET in integrated circuits, Common mode properties.

Noise- Statistical characteristics of noise- Types of noise: significance of flicker and thermal. Analysis and representation of noise in single-stage amplifiers: CG, CS, CD (source follower) and cascode stage and noise in differential pairs. Representation of noise in circuits- Noise in single- stage amplifiers- Noise in differential pairs- Noise Bandwidth.

Feedback topologies (voltage-voltage, current-voltage, voltage-current, current-voltage) and the noise and the loading effect analysis, Negative feedback, Stability of negative feedback systems, Stability and frequency compensation: Specification analysis, multi-pole system, three-stage opamp, phase margin Frequency compensation, pole-zero doublet analysis.

Design of the CMOS operational amplifiers: One-stage opamps and two-stage opamps, Gain boosting techniques, folded cascode, telescopic amplifier, common mode feedback (CMFB) amplifier, Three-stage opamp architectures, opamp specifications analysis, Design of high-speed and high-gain amplifiers.

CMOS amplifier Frequency response: Miller effect, common source (CS), common gate (CG), common drain (CD) stages, and cascode stage Analog layout techniques for MIM, MOM and fringe capacitor.

Text/Reference Books:

1. "Design of Analog CMOS Integrated Circuits" by Behzad Razavi, McGraw Hill Education (1 September 2000).
2. CMOS Analog Circuit Design" by Phillip Allen and Douglas R. Holberg, OUP USA; Third Edition edition (1 September 2011).
3. "Operation and Modeling of the MOS Transistor" by Yannis Tsividis, Oxford University Press; 2 edition, June 26, 2003.
4. "Microelectronic Circuits-Theory & Applications" by A.S. Sedra and K.C. Smith, Adapted by A.N. Chandorkar, 6th Edition, Oxford, 2013.
5. A.V.N. Tilak, Design of Analog Circuits, Khanna Publishing House, 2022.

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Realize the concepts of Analog MOS devices and current mirror circuits.
2. Design different configurations of Amplifiers and feedback circuits.

3. Analyze the characteristics of the frequency response of the amplifier and its noise.
4. Analyze the performance of the stability and frequency compensation techniques of Op-Amp Circuits.

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UGEVT601B	**Semiconductor Device Modelling**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Semiconductors in Equilibrium and Carrier Transport, Semiconductor Materials, Carrier Concentration, Carrier Drift, Carrier Diffusion, Generation and Recombination Process, Continuity Equation, Thermionic Emission, Tunnelling, Ballistic Transport, High Field Effects, Physics of Junction Devices: Thermal Equilibrium Condition, Depletion region, Depletion, and Diffusion Capacitances, Current‑Voltage characteristics, Charge Storage and Transient behavior, Junction Breakdown, Metal Semiconductor Contacts, forward and reverse-biased junctions, reverse- bias breakdown, transient, and a-c conditions.

Physics of Bipolar devices: Transistor action, Static Characteristics, minority carrier distribution and terminal currents, generalized biasing, secondary effects, Frequency Response and Switching, Semiconductor Heterojunctions.

Field-Effect Transistors: JFET- current-voltage characteristics, effects in real devices, high- frequency and high-speed issues, Metal Insulator Semiconductor FET.

MOSFET- basic operation and fabrication, ideal MOS capacitor, Energy band diagram in equilibrium and under bias, Flat band voltage, Potential Balance and charge balance, Effect of gate body voltage on surface condition, Accumulation and depletion, Inversion, CV Characteristics, Frequency response, threshold voltages, output and transfer characteristics of MOSFET, short channel and Narrow width effects, MOSFET scaling.

Optoelectronics Devices: Light emitting diodes, Lasers, Photoconductors, Junction Photodiodes, Avalanche Photodiodes, Solar Cells, SPICE Models for Semiconductor Devices: MOSFET Level 1, Level 2 and level 3 model, Model parameters; SPICE models of p-n diode and BJT.

Text/Reference Books:

1. B. G. Streetman and S. Banerjee, Solid State Electronic Devices, 6th Edition, PHI Private Limited, 2011.
2. T. A. Fjeldly, T. Ytterdal, and M. Shur, “Introduction to Device Modelling and Circuit Simulation”, John Wiley, 1998.
3. Introduction to Semiconductor Materials and devices by M.S Tyagi, John Wiley & Sons, 5th Edition, 2005.
4. G. Massobrio and P. Antognetti, Semiconductor Device Modelling with SPICE, 2nd Edition, TMH, 2010.

5. C. C. Hu, Modern Semiconductor Devices for Integrated Circuits, Pearson Education, 2010.
6. P. Bhattacharya, Semiconductor Optoelectronics Devices, 2nd Edition, PHI, 2009.
7. A.K. Maini, N. Maini, All-in-One Electronics Simplified, Khanna Book Publishing, New Delhi, 2021.
8. A.K. Maini, Analog Electronics, Khanna Book Publishing, New Delhi, 2022.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Explain the equations, approximations, and techniques available for deriving a model with specified properties, for a general device characteristic with known qualitative theory.
2. Apply suitable approximations and techniques to derive the model starting from drift-diffusion transport equations (assuming these equations hold).
3. Offer clues to a qualitative understanding of the physics of a new device and conversion of this understanding into equations.
4. Simulate characteristics of a simple device using MATLAB, and SPICE tools.

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UGEVT801A	CAD for VLSI	3L:0T:0P	3 credits

Detailed Contents:

Overview of digital logic design, Simplification of switching functions, K-map-based reduction of switching functions.

Combinational logic design, Complex combinational logic modules such as multiplexers/ demultiplexers, decoders, PLAs, and their use in standardized combinational logic design.

Memory elements and time delay concepts, Flip-flops, latches, registers; Sequential circuit concepts and state diagrams; Clock-mode sequential circuits analysis and design; Synthesis of state diagrams; Fundamental-mode sequential circuits.

Analysis and design, hazards, races, and cycles. Logic element realization: Ideal switch based implementation; Logic families; FET switches; MOS switch-based logic realization; NMOS and CMOS logic-Pass transistor logic; Algorithmic optimization of combinational logic; VLSI realization of combinational logic.

Language-based description of complex digital systems; RTL descriptions and design language representation; Levels of description; Behavioral and structural descriptions; VHDL and Verilog.

Text/Reference Books:

1. De Micheli G., Synthesis and Optimization of Digital Circuits, McGraw Hill, (1994).

2. Devadas, S. A., Abhijith Ghosh, A., and Keutzer, K., Logic Synthesis, Kluwer Academic, (1998).
3. Brunvand, E., Digital VLSI Chip Design with Cadence and Synopsys CAD Tools, Addison-Wesley, (2010).
4. R. Anand, Digital System Design Using VHDL, Khanna Book Publishing Company.
5. R. Anand, Digital Electronics, Khanna Book Publishing Company.
6. Gerez, S.H., Algorithms for VLSI Design Automation, Wiley, (1999).
7. Pan, D.Z., VLSI Physical Design Automation, The University of Texas at Austin, (2015).
8. Nowick, S. M., Bhardwaj, K. Computer-Aided Design of Digital Systems, Columbia University, (2016).

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. This course deals with the fundamentals of Computer-Aided Design (CAD) tools for the design, analysis, synthesis, test, verification.
2. Design and analysis of Computer-Aided Design (CAD) tools for the routing and placement of digital Very Large-Scale Integration (VLSI) systems.

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UGEVT802A	**Semiconductor Optoelectronics**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Review of Semiconductor Device Physics: Energy bands in solids, the E-k diagram, Density of states, Occupation probability, Fermi level, and quasi-Fermi levels, p-n junctions, Schottky junction, and Ohmic contacts. Semiconductor optoelectronic materials, Bandgap modification, Heterostructures, and Quantum Wells.

Interaction of photons with electrons and holes in a semiconductor: Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier.

Semiconductor Photon Sources: Electroluminescence. The LED: Device structure, materials and characteristics. The Semiconductor Laser: Basic structure, theory, and device characteristics, direct current modulation, Quantum-well lasers; DFB-, DBR- and vertical-cavity surface-emitting lasers (VCSEL), Laser diode arrays, Device packages, and handling.

Semiconductor Optical Amplifiers & Modulators: Semiconductor optical amplifiers (SOA), SOA, characteristics and some applications, Quantum-confined Stark Effect and Electro-Absorption Modulators.

Semiconductor Photodetectors: Types of photodetectors, Photoconductors, Single junction under illumination: photon and carrier-loss mechanisms, Noise in photodetection; Photodiodes, PIN diodes, and APDs: structure, materials, characteristics, and device performance. Photo-transistors, solar cells, and CCDs.

Optoelectronic integrated circuits - OEICs.

Text/Reference Books:

1. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., 2nd Ed. (2007), Ch.16, 17, and 18.
2. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
3. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
4. G. Keiser, Optical Fiber Communications, McGraw-Hill Inc., 3rd Ed. (2000),Ch.4, 6.
5. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York (2007), 6th Ed. Ch.15-17.
6. J. M. Senior, Optical Fiber Communication: Principles and Practice, Prentice Hall of India, 2nd Ed. (1994), Ch.6-8.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Acquire a fundamental understanding of the basic physics behind optoelectronic devices.
2. Develop a basic understanding of light-emitting diodes.
3. Develop detailed knowledge of laser operating principles and structures.
4. Acquire a depth understanding of photodetectors.
5. Acquire detailed knowledge of solar cells and optoelectronic modulation and switching devices.
6. Develop a basic understanding of optoelectronic integrated circuits.

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UGEVT601C	**Introduction to MEMS**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Introduction to MEMS: Historical Background, Scaling Effects. Micro/Nano Sensors, Review of Basic MEMS fabrication modules, Oxidation, Deposition Techniques, Lithography (LIGA), and Etching.

Micromachining, Surface Micromachining, sacrificial layer processes, Stiction, Bulk Micromachining, Isotropic Etching, and Anisotropic Etching, Wafer Bonding, Mechanics of solids in MEMS/NEMS.

Micro-actuators and Micro-sensors: Micro-sensors, acoustic wave sensors, biomedical and nano- sensors, chemical sensors, optical sensors, pressure sensors, thermal sensors, micro-actuation through thermal forces, SMA-Piezo electric crystals, and electrostatic forces, magnetic actuation, micro-grippers, micro-motors, micro-valves,micropumps, micro-accelerometers.

Materials, Mechanics and design of micro-systems: Silicon as a substrate, compounds, piezo- resistors, polymers, and packaging materials, micro-fabrication and micro-etching: static bending of thin plates, thermo mechanics and thin film mechanics.

Case studies of MEMS Products: Micro-fluidic devices, micro/nano transducers, blood pressure sensors, microphone-acceleration sensors, gyroscope, an overview of micro-system packaging.

Text/Reference Books:

1. Marc Madou, Fundamentals of Microfabrication and Nanotechnology (3 rd edition);
2. Stephen D. Senturia, Microsystem Design.
3. Gregory T.A. Kovacs, Micromachined Transducers.
4. Guozhong Cao,Ying, Nanostructure and Nano materials, synthesis, properties and applications, World Scientific Publishing Co. 2011.
5. Chang Liu, Foundation of MEMS, Pearson Education, ISBN (978-81-317-6475-6).

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand fundamental principles of sensing and actuation and corresponding scaling laws in MEMS.
2. Gain a comprehensive perspective of various fabrication processes and materials used in microfabrication.
3. Understand the principle, design, and fabrication techniques of leading exemplary devices in the MEMS industry.
4. Design basic MEMS devices using relevant mechanical/electrical/fluidic engineering principles.

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UGEVT703C	**Semiconductor Packaging and Testing**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Overview of electronic systems packaging: Introduction and Objectives of the course definition of a system and history of semiconductors, Products and levels of packaging, Packaging aspects of handheld products, Case studies in the application.

Semiconductor Packaging Overview: Basics of Semiconductor and Process flowchart; Video on “Sand-to-Silicon”, Wafer fabrication, inspection and testing, Wafer packaging; Packaging evolution, Chip connection choices, Wire bonding, TAB and flipchip-1, TAB and flipchip-2, Need for packaging & Single

chip packages or modules (SCM), Commonly used packages and advanced packages, Materials in packages, Thermal mismatch in packages, Current trends in packaging, Multichip modules (MCM)-type, System-in-package (SIP), Packaging roadmaps, Hybrid circuits.

Electrical Design considerations in systems packaging (L. Umanand): Electrical Issues – I Resistive Parasitic, Electrical Issues – II; Capacitive and Inductive Parasitic, Electrical Issues – III; Layout guidelines and the Reflection problem, Electrical Issues – IV; Interconnection, CAD for Printed Wiring Boards: Benefits from CAD; Introduction to DFM, DFR & DFT, Components of a CAD package and its highlights, Design Flow considerations; Beginning a circuit design with schematic work and component layout, Demo and examples of layout and routing; Technology file generation from CAD; DFM checklist and design rules; Design for Reliability.

Printed Wiring Board Technologies: Board-level packaging aspects, Review of CAD output files for PCB fabrication, Photo plotting, and mask generation, Process flow-chart; Vias; PWB substrates, Surface preparation, Photoresist and application methods, UV exposure and developing, Printing technologies for PWBs, PWB etching, Resist stripping, Screen-printing technology, Through-hole manufacture process steps, Panel and pattern plating methods, Solder mask for PWBs, Multilayer PWBs; Introduction to microvias, Microvia technology, and Sequential build-up technology process flow for high-density interconnects, Conventional Vs HDI technologies; Flexible circuits.

Surface Mount Technology: SMD benefits; Design issues; Introduction to soldering, Reflow, and Wave Soldering methods to attach SMDs, Solders: Wetting of solders; Flux and its properties, Defects in wave soldering, Vapor phase soldering, BGA soldering, and desoldering/ Repair, SMT failures, SMT failure library, Tin Whiskers, Tin-lead, and lead-free solders; Phase diagrams, Thermal profiles for reflow soldering, Lead-free alloys, Lead-free solder considerations; Green electronics; RoHS compliance and e-waste recycling issues.

Thermal Design considerations in systems packaging, Introduction to embedded passives: Need for embedded passives, Design Library, Embedded resistor processes, Embedded capacitors; Processes for embedding capacitors.

Text/Reference Books:

1. Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw Hill, NY, 2001.
2. William D. Brown, Advanced Electronic Packaging, IEEE Press, 1999.
3. Bosshart, Printed Circuit Boards Design and Technology, TataMcGraw Hill, 1988.
4. Blackwell (Ed), The electronic packaging handbook, CRC Press, 2000.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Give a comprehensive introduction to the various packaging types used along with the associated thermal, speed, signal, and integrity power issues.
2. Enable the design of packages that can withstand higher temperatures, vibrations, and shock.
3. Design of PCBs that minimize the EMI and operate at a higher frequency
4. Analyze the concepts of Testing and testing methods.

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UGEVT703A	**Mixed-signal Design**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Building blocks for CMOS amplifiers: design of current mirrors, differential amplifiers, CMOS operational transconductance amplifiers: design of single ended telescopic cascode, folded cascode and two-stage amplifiers.

Frequency compensation schemes: Miller compensation, Ahuja compensation and Nested Miller compensation.

Design of fully differential amplifiers, discussion of common mode feedback circuits. Switched capacitor circuits, design of switched capacitor amplifiers and integrators, effect of opamp finite gain, bandwidth and offset, circuit techniques for reducing effects of opamp imperfections, switches and charge injection and clock feed-through effects.

Design of sample and hold and comparators. Fundamentals of data converters; Nyquist rate A/D converters (Flash, interpolating, folding flash, SAR, and pipelined architectures); Nyquist rate D/A converters - voltage, current and charge mode converters, hybrid, and segmented converters); Oversampled A/D and D/A converters.

Design of PLL's and DLL's and frequency synthesizers.

Text/Reference Books:

1. R. Gregorian and Temes - Analog MOS integrated circuits for signal processing.
2. R.Gregorian - Introduction to CMOS opamps and comparators.
3. D.Johns and K.Martin - Analog integrated circuit design.
4. B.Razavi - Monolithic Phase-locked loops and clock recovery circuits: Theory and design.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. understanding of metal-oxide-semiconductor field-effect transistors and the relationship of process technology with models used for analog IC.
2. CMOS digital circuits will be introduced and analyzed. It provides exposure to the complex, non-digital behavior of the devices and circuits with which digital systems are implemented. Emphasis is given on the circuit design, optimization, and layouts.

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UGEVT802B	**Bio-Medical Electronics**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Cell and its structure – Resting and Action Potential – Nervous system and its fundamentals - Basic components of a biomedical system- Cardiovascular systems- Respiratory systems -Kidney and blood flow - Biomechanics of bone - Biomechanics of soft tissues - Basic mechanics of spinal column and limbs -Physiological signal.Sensors and Transducers: Signal Acquisition, Transduction, Tactics, and Signal Processing for Improved Sensing, Electrodes: Limb electrodes –floating electrodes – pregelled disposable electrodes,needle, surface electrodes, Microelectrodes, Strain Gauges, Quartz Pressure Sensors, Matching Sensors to Circuits, Temperature, Capacitive, and Inductive Transducers.

Bioelectric Amplifiers: Signal Processing Circuits, Practical Op-Amps, Isolation Amplifiers Chopper Stabilized Amplifiers, Electrocardiographs: The Heart as a Potential Source, The ECG Waveform, The Standard Lead System, Other ECG Signals, The ECG Preamplifier ECG Readout Devices, ECG Machines, ECG Maintenance/Troubleshooting.

Physiological Pressure and Other Cardiovascular Measurements and Devices: Physiological Pressures, Pressure Measurements, Blood Pressure Measurements Oscillometric, and Ultrasonic Noninvasive Pressure Measurements.

Pressure Amplifier Designs, Ac Carrier Amplifiers, Systolic, Diastolic, and Mean Detector Circuits, Pressure Differentiation (dP/dT) Circuits, Practical Problems in Pressure Monitoring, Step-Function Frequency Response Test, Defibrillator Circuits, Pacemakers.

Medical Ultrasonography: Ultrasound Transducers, Absorption, and Attenuation of Ultrasound Energy, Biological Effects of Ultrasound, Doppler Effect, Transcutaneous Doppler Flow Detector, Flowmeters, Ultrasonic Blood Pressure Measurement.

Text/Reference Books:

1. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw-Hill, New Delhi, 2

Edition, 2003.
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment and Technology, 4th edition. Upper Saddle River, New Jersey: Prentice-Hall, 2001.
3. Sabrie Soloman, 3D Bioprinting Revolution, Khanna Publishing House, 2020.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. An ability to conduct standard tests, measurements, and experiments and to analyze and interpret the result to improve processes.
2. Have adequate knowledge about different types of Electrodes, Transducers, and Amplifiers.
3. Understand the important and modern methods of imaging techniques.

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UGEVT703B	RF Microelectronics	3L:0T:0P	3 credits

Detailed Contents:

Introduction to RF and Wireless Technology, Basic concepts in RF design: Units in RF Design, Time Variance, and Nonlinearity. Effects of Nonlinearity: Harmonic Distortion, Gain Compression, Cross Modulation, Intermodulation, AM/PM Conversion, Noise: Noise Spectrum, Representation of Noise in Circuits, Effect of Transfer Function on Noise, Sensitivity, Passive Impedance Transformation, Series-to-Parallel Conversion, Basic Matching Networks, Loss in Matching Networks, Analysis of Nonlinear Dynamic Systems, Method of Nonlinear Currents and related problems.

Communication Concepts: AM, FM, PM, Digital Modulation: Quadrature Modulation, GMSK and GFSK Modulation, QAM, WM, Mobile RF Communications, Multiple Access Techniques: TDMA, FDMA, CDMA, Wireless Standards: GSM, IS-95 CDMA, Wideband CDMA, Bluetooth, IEEE802.11a/b/g.

Transceiver Architectures: Receiver Architectures, Modern Heterodyne Receivers, Image-Reject Receivers, Low-IF Receivers, Transmitter Architectures: Direct-Conversion Transmitters, Modern Direct-Conversion Transmitters, Heterodyne Transmitters, OOK Transceivers, Low-Noise Amplifiers: LNA Topologies, Common-Source Stage, Common-Gate Stage, Noise-Cancelling LNAs, High-IP2 LNAs, Differential LNAs.

Mixers: Single-Balanced and Double-Balanced Mixers, Passive Down-conversion Mixers, LO Self-Mixing, Current-Driven Passive Mixers, Active Down-conversion Mixers. Improved Mixer Topologies: Current-Source Helpers, Enhanced Trans conductance, Low Flicker Noise. Passive Devices: Inductors, Transformers, Transmission Lines, Constant Capacitors.

Oscillators: Performance Parameters, Cross-Coupled Oscillator, Three-Point Oscillators, Voltage-Controlled

Oscillators, LC VCOs with Wide Tuning Range. Low-Noise VCOs, Mathematical Model of VCOs. Quadrature Oscillators. Power Amplifiers: Efficiency, Classification of Power Amplifiers, Basic Linearization Techniques, Polar Modulation, Doherty Power Amplifier. Concept of RF-SOC FPGA boards.

Text/Reference Books:

1. B. Razavi, "RF Microelectronics", Pearson Education, 2nd Edition, 2012.
2. Thomas Lee, "The Design of CMOS Radio Frequency Integrated Circuits", Cambridge University Press, 2nd Edition, 2004
3. B.Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2001.
4. Recorded lectures and notes available at .http://www.ee.iitm.ac.in/~ani/ee6240/

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UGEVT704B	**Digital image processing**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Introduction to digital image processing : What is image processing, Different types of images, Visual perception, Image sensing and Acquisition, Quantization, Sampling, color image processing, Revision of Mathematical concepts for image processing, Intensity transformation, Filtering in spatial and Frequency domain: Image negatives, Log transformations, Histogram processing, Spatial filter: smoothing and Sharpening, Discrete Fourier transform, properties of 2-D DFT, Image smoothing and Sharpening in Fourier domain

Image transforms: Two-dimensional orthogonal and Unitary transforms, Optimum transform, Properties of Unitary transforms, 2D DFT, Cosine transforms, Hadamard transforms, KL transforms, Comparison of image transforms, Edge detection: Gradient and Laplacian based edge detection, Diffusion based edge detection: Isotropic and anisotropic diffusion.

Wavelet transform for Image Processing: Multi resolution expansion, Wavelet functions, Wavelet Series expansion, Continuous and Discrete Wavelet transforms, Wavelet transforms for two- dimensional signals (images), Applications of wavelet transforms for edge extraction, noise suppression.

Image segmentation: Thresholding, region-based Morphological Watersheds, Bayesian-base image segmentation. Image restoration and reconstruction: Models of image degradation, noise models, Spatial and Frequency domain-based approaches for image restoration, Inverse filtering, Wiener Filtering, Bayesian denoising.

Image Compression: Spatial and Temporal redundancy, Basic image compression models, compression standards, basic compression methods: Huffman coding, Run-length coding, Block transform coding,

Predictive coding. Color Image Processing: Color Fundamentals, Color Models, Color transformation, smoothing, sharpening and edge detection in color images.

Text/Reference Books:

5. R. C. Gonzalez and R. E. Woods, " Digital Image Processing" Third edition, Pearson Education, 2009.
6. Anil K Jain, "Fundamental of Digital Image Processing", Prentice Hall, 1989.
7. A. C. Bovik, "The essential guide to image processing", Second edition, Academic Press, 2009.
8. A. M. Teckalp, "Digital Video Processing", Prentice Hall PTR, 1995.

Course outcome:

At the end of this course, students will demonstrate the ability to

1. Review the fundamental concepts of a digital image processing system.
2. Analyze images in the frequency domain using various transforms.
3. Evaluate the techniques for image enhancement and image restoration.
4. Categorize various compression techniques.
5. Interpret Image compression standards.
6. Interpret image segmentation and representation techniques.

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UGEVT701A	**Low power VLSI**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Basics of MOS circuits: MOS Transistor structure and device modeling MOS Inverters MOS Combinational Circuits - Different Logic Families.

Sources of Power dissipation: Dynamic Power Dissipation Short Circuit Power Switching Power Gliching Power Static Power Dissipation Degrees of Freedom.

Supply Voltage Scaling Approaches: Device feature size scaling Multi-Vdd Circuits Architectural level approaches: Parallelism, Pipelining Voltage scaling using high-level transformations Dynamic voltage scaling Power Management

Switched Capacitance Minimization Approaches: Hardware Software Tradeoff Bus Encoding Two's

complement Vs Sign Magnitude Architectural Optimization Clock Gating Logic styles.

Leakage Power minimization Approaches: Variable-threshold-voltage CMOS (VTCMOS) approach

multi-threshold-voltage CMOS (MTCMOS) approach Power gating Transistor stacking Dual-Vt assignment approach (DTCMOS)

Text/Reference Books:

1. Sung Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata Mcgrag Hill.
2. Neil H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design, 2nd Edition, Addison Wesley (Indian reprint).
3. A. Bellamour, and M. I. Elmasri, Low Power VLSI CMOS Circuit Design, Kluwer Academic Press, 1995.
4. Anantha P. Chandrakasan and Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers, 1995.
5. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Design, Wiley-Interscience, 2000.

Course outcome:

At the end of this course, students will demonstrate the ability to

1. Capability to recognize advanced issues in VLSI systems, specific to the deep-submicron silicon technologies.
2. Students able to understand deep submicron CMOS technology and digital CMOS design styles.
3. To design chips used for battery-powered systems and high-performance circuits.

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UGEVT801B	High Speed Interfacing Circuits	3L:0T:0P	3 credits

High Speed Interfacing Circuits

Learning Goals:
1. Learn fundamentals of high-speed data link design
2. Learn system architecture using modeling tools
3. Understand the challenges of designing high-speed wireline circuits through a design project using advanced CMOS.
4. Be exposed to several link standards, including USB-Type C, Thunderbolt, PCIe and DDR.

Topics Covered:
- Introduction to high-speed links

- Channel characterization
- Noise and jitter
- Equalization
- Signaling schemes
- Transmitter circuit design Receiver circuit design
- Different clocking schemes
- Timing recovery
- Power and Clock Distribution

Books
Digital Systems Engineering, W. Dally and J. Poulton, Cambridge University Press, 1998
and IEEE journals.

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UGEVT704A	**Power converters design**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Review of basic power electronics principles, Introduction to various power electronics supplies. Performance parameters for power electronics supplies and their measurement.

DC to DC converters: Analysis and design of cuk converters, two quadrant and full bridge Non isolated converters, Isolated converters, i.e., flyback, forward, push-pull, half- bridge, full bridge Zeta, and SEPIC topology, block diagram of converter control, modeling such as averaged model, linearized and state space model Design of DC inductor, Concept of integrated magnetic.

Soft switching DC to DC converters, zero current switching topologies, zero voltage switching topologies, generalized switch cell, ZCT and ZVT DC converters, design, and simulation.

Pulse width modulation rectifiers, properties of ideal rectifiers, Realization of near deal rectifiers, CCM boost converter, DCM flyback converters, control of current waveforms, AC Choppers: Modeling and analysis of AC choppers, harmonics control using symmetrical and asymmetrical waveform pattern, design, and simulation.

Static un-interruptible power supply, on-line, off-line and line interactive UPS, modes of operation, batteries and converters selection and design for UPS, performance evaluation of UPS, power factor correction techniques, control of UPS.

Text/Reference Books:

1. P.S. Bimbhra, Power Electronics, Khanna Book Publishing Company, 2022.
2. Issa Batarseh, "Power Electronics Circuits", John Wiley & Sons Inc 2004.
3. Ned Mohan, "Power Electronics: Converters, Applications, and Design", John Wiley; Sons Inc 2003.
4. 3. M. H. Rashid, "Power Electronics Circuits, Devices and Applications", third edition Pearson Education India, 2009. 4. L. Umanand, "Power Electronics Essential and Applications", Wiley India 2009.
5. 4. R. W. erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2013.
6. 5. Y.S Lee, "Computer Aided Analysis and Design of Switch Mode Power Supplies", Marcel Dekker, New York 1993.
7. D. C. Griffith, "Uninterruptible Power Supplies", Marcel Dekker Inc, New York 1993.
8. K. Billing, "Switch Mode Power Supply Handbook", third edition McGraw Hill, Boston 2010.
9. Madhukar Waware, D. S. More, Vijay Mohale, Abhay Wagh, Power Electronics and Its Applications, Khanna Publishing House, 2022.

Course outcomes:

At the end of this course students will demonstrate the ability to

1. Understanding of power electronics concepts, be able to classify DC-DC and AC/DC power electronic converters as per the performance requirement of Power Supplies.
2. Analyse and design conventional DC-DC converter topologies and be capable of developing their mathematical models aiding the steady state and transient analysis.
3. Develop understanding of conventional AC/DC converter topologies and be able to classify and design them based on their power stages, control aspects and other issues like source current quality control etc.
4. Able to classify the different layouts of uninterruptible power supplies, compare the applicable control strategies and identify the various standards followed in this area

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UGEVT802C	**Organic Electronics**	**3L:0T:0P**	**3 credits**

Organic Electronics: -

1. Electric properties of matter

The electron, The electron gas – Drude's theory, The Fermi gas – Sommerfeld's theory, Electrons in a magnetic field, Beyond the electron gas model

2. Intermolecular interactions
Electrostatic interactions, Hydrogen bond, Interactions involving pi-electron systems
3. Structure and Scattering
Bravais lattices and crystal structures, Scattering and diffraction
4. Physics of quasi one-dimensional conductors
Mean field theory of the Peiperl's transition, Rudiments of the Luttinger liquid model
5. Organic conductors and superconductors
The wondrous (TMTSF) 2 PF 6, The two-chain perylene-metal dithiolate series, Peierls and spin-Peierls instabilities and precursor effects, The nature of the instabilities in Ni, Pd and Pt salts
6. Organic semiconductors for Organic electronics
Molecular, crystal and electronic structures, Solitons, polarons and bipolarons, Transport and optical properties
7. Organic electronics devices
Organic light-emitting diodes, Organic solar cells, Organic transistors
8. Molecular-scale electronic devices
Transport at the nanoscale, Quantum effects in molecular junctions

References Book: -
1. The Physics of Organic Electronics by Luís Joaquim Alcácer.
2. Organic Electronics Foundations to Applications by Stephen R. Forrest.

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UGEVT702C	**Flexible Electronics**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Introduction to Flexible and Printed Electronics: Evolution of Flexible Electronics, review of cutting- edge research on electronics that can be flexible, plastic, stretchable, conformable or printed. Electronic materials, components, and systems, applications for IoT.

Materials, Processing, and Manufacturing: Various semiconductors, dielectric, and conducting materials, Organic semiconductors, from chemical bonds to bands, Charge injection and transport,

Examples of printable functional materials, Thin-film Deposition and Processing Methods for Flexible Devices, Solution-based Patterning Processes; Ink-jet printing, gravure, and other processes, surface energy effects, multilayer patterning.

Flexible Thin-Film Transistors and Circuits: Thin-Film Transistor; Device structure and performance, Electrical characteristics, parameter extraction, characterization methods for rigid and flexible devices,

electrical stability, printed transistors; organic/polymer, metal-oxide, electrolyte gated, Case studies; sub micrometer OTFTs and gravure printed OTFTs, From transistors to circuits.

Circuits on flexible and non-silicon substrates, Contacts, and Interfaces to Organic and Inorganic Electronic Devices: Schottky contacts, defects, carrier recombination, the effect of applied mechanical strain.

Other Flexible Devices and System Integration: Organic Light Emitting Diodes, Organic Solar Cells, thin flexible OLED displays, OLED lighting, smart wallpaper, sensors, logic, and memory, RFID tags, Latest applications of printed electronics, Encapsulation, Roll to roll printing processes, Integration Issues, and Designs for the Future.

Text/Reference Books:

1. G. Nisato, D. Lupo, S. Ganz (Editors) (2016), Organic and Printed Electronics: Fundamentals and Applications, CRC Press.
2. M. M. Hussain and N. El-Atab, *Handbook of Flexible and Stretchable Electronics*, CRC Press, 2020.
3. Sabrie Soloman, 3D Bioprinting Revolution, Khanna Publishing House, 2020.
4. Large Area and Flexible Electronics, Mario Caironi & Yong-Young Noh (Editors (2015), WILEY-VCH.
5. Wong, William S., and Alberto Salleo, (Eds.) (2009) Flexible electronics: materials and applications. Vol. 11. Springer
6. Recent Journal Papers form Flexible and Printed Electronics, IOP, and Organic Electronics, Elsevier.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Identify the advantages, drawbacks, performances, complementarity, and uniqueness of large- area manufacturing vs. silicon technology.
2. Integrate the operation principles, architectures, and processing of main devices and systems fabricated for flexible electronics.
3. Predict systems integration issues and propose methods for integration and encapsulation of printed devices and systems.

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UGEVT701B	**Nanoelectronics**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Overview: Nanodevices, Nano materials, Nano characterization, Definition of Technology node, Basic

CMOS Process flow, MOS Scaling theory, Issues in scaling MOS transistors: short channel effects, Description of a typical 65 nm CMOS technology.

Requirements for Nonclassical MOS transistor, MOS capacitor, Role of interface quality and related process techniques, Gate oxide thickness scaling trend, SiO2 vs High-k gate dielectrics. Integration issues of high-k Interface states, bulk charge, band offset, stability, reliability – Qbd high field, possible candidates, CV and IV techniques.

Metal gate transistor: Motivation, requirements, Integration Issues, Transport in Nano MOSFET, velocity saturation, ballistic transport, injection velocity, velocity overshoot.
SOI - PDSOI and FDSOI, Ultrathin body SOI – double gate transistors, integration issues, Vertical transistors - FinFET and Surround gate FET, Metal source/drain junctions – Properties of Schottky junctions on Silicon, Germanium, and compound semiconductors-Work function pinning. Germanium Nano MOSFETs: strain, quantization, Advantages of Germanium over Silicon, PMOS versus NMOS.

Compound semiconductors – material properties, MESFETs Compound semiconductors MOSFETs in the context of channel quantization and strain, Heterostructure MOSFETs exploiting novel materials, strain, quantization.

Synthesis of Nanomaterials: CVD, Nucleation and Growth, ALD, Epitaxy, MBE. Compound semiconductor hetero-structure growth and characterization: Quantum wells and Thickness measurement techniques: Contact - step height, Optical - reflectance and ellipsometry. AFM. Characterization techniques for nanomaterials: FTIR, XRD, AFM, SEM, TEM, EDAX etc. Applications and interpretation of results. Emerging nano materials: Nanotubes, nanorods and other nano structures, LB technique, soft lithography etc. Microwave-assisted synthesis, Self-assembly etc.

Text/Reference Books:

1. Fundamentals of Modern VLSI Devices, Y. Taur and T. Ning, Cambridge University Press.
2. Silicon VLSI Technology, Plummer, Deal, Griffin Pearson Education India.
3. Encyclopedia of Materials Characterization, Edited by: Brundle, C.Richard; Evans, Charles A. Jr.;Wilson, Shaun ; Elsevier.

Course outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the fundamentals of classical CMOS technology and the issues in scaling MOSFET in the sub-100nm regime.
2. Students are able to analyze the non-classical transistors with new device structures and nanomaterials.
3. Understand the issues in realizing Germanium and compound semiconductor MOSFET and extensive materials characterization techniques that help in designing high-performance transistors.

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Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Electronics Engineering (VLSI Design and Technology)

(Applicable from the academic session 2023-2024)

UGEVT801C	**Heterojunction Device Physics**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Semiconductor abrupt junctions, Equilibrium conditions, the contact potential, space charge at a semiconductor junction, qualitative description of current flow at a junction, minority, and majority carrier currents, carrier injection, minority carrier distributions, variation of the quasi-Fermi levels with the position, junction current from excess minority carriers, junction breakdown mechanisms, capacitance of p-n junctions.

Semiconductor heterojunctions: Types of heterojunctions, energy band diagrams of heterostructures, current-voltage and, capacitance-voltage characteristics of anisotype heterojunctions, heterojunction bipolar transistors, electrical and optical characteristics of LEDs, laser gain semiconductor band system, high electron mobility transistor, hot electron heterojunction transistor.

2D electron gas and Quantum wells: 2D electron gas in Si and GaAs MOS structures, effect of applied bias on energy bands of the MOS capacitors, bias dependence of capacitance, free charge carrier transfer.

Triangular quantum wells (both finite and infinite), coupled quantum wells, and superlattices, double heterostructure lasers, single quantum well lasers, multiple quantum well lasers. Optical absorption due to electronic transistions in quantum wells .

Transport properties of heterostructures and quantum devices: Effect of electric field parallel and perpendicular to the interfaces, effects of constant magnetic field, Landau levels, magneto conductivity in a 2D heterostructure. One-D and Zero-D quantum structures.

The density of states in 3D, 2D, 1D and 0D structures, 1D and 0D optical phenomena and optical devices, quantum confined stark effect, quantum well modulators, self-electro-optic effect devices, resonant tunneling devices, the coulomb blockade, single electron transistor.

Text/Reference Books:

1. Semiconductor heterojunctions by B. L. Sharma and R. K. Purohit, Pergamon press.
2. Heterojunction and metal-semiconductor junctions by A. R. Milnes and D. L. Hench, Academic press.
3. Solar cells by H. J. Hovel.
4. Solid-state electronic devices by B. G. Streetman.
5. Luminescence and LED by E. W. Williams and R. Hall.
6. Semiconductor physics and applications by M. Balkanski and R. F. Wallis, Oxford University Press.

Course outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the band structure of heterojunction devices and transport mechanisms.
2. Analyze the electrical behavior of 2D heterojunctions.
3. Understand the density of states in different dimensional structures like 0D, 1D, 2D, and 3D.

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UGEVT702B	**Internet of things**	**3L:0T:0P**	**3 credits**

Detailed Contents:

An introduction to IoT systems: Introduction and motivation of IoT systems, Hardware components of IoT systems: A quick overview of different components---micro-controllers, SoCs, communication modules, power supply and sensing modules---of off-the-shelf prototyping boards, e.g., Arduino UNO, MSP430 LaunchPad; NodeMCU, STM32.

The software component of IoT systems: Introduction to IDEs for off-the-shelf boards, e.g., Arduino IDE, Waspmote IDE, Code composed studio; Contiki-OS and RIOT OS; 6LowPAN network stack; Sensor interfacing; GPIO programming.

Communication paradigm of IoT systems: Different wireless standards, e.g., IEEE802.15.4, ZigBee, BLE, IEEE802.11; link layer technologies, Medium Access Control; Routing; Application layer protocols; Network topologies.

Performance evaluation of IoT systems: Developing mathematical models for energy consumption, Optimal node placement, and resource allocation over wireless sensor networks to meet QoS requirements. Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi. Implementation of IoT with Raspberry Pi (contd), Introduction to SDN, SDN for IoT.SDN for IoT (contd), Data Handling and Analytics.

Cloud Computing, Cloud Computing(contd), Sensor-Cloud. Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Industrial IoT (contd), Case Study: Agriculture, Healthcare, Activity Monitoring.

Text/Reference Books:

1. “Internet of Things”, by Dr. Jeeva Jose, Khanna Book Publishing Company, New Delhi.
2. “Introduction to Security of Cyber-Physical Systems”, by Dr. Jeeva Jose & Vijo Mathew, Khanna Book Publishing Company.
3. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press).
4. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press).
5. David Hanes et al., IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things, First edition, Pearson, 2017.
6. Parry Lea, Internet of Things for Architects: Architecting IoT Solutions by Implementing Sensors, Communication Infrastructure, Edge Computing, Analytics, and Security, Packt Publishing Limited, 2018.

Course outcomes:

At the end of this course, students will demonstrate the ability to

1. students will be familiar with different prototyping boards and their components. They will be able to choose an appropriate board/component for designing an IoT system.
2. Have hands-on experience in programming off-the-shelf boards using respective IDEs. Additionally, they will be able to choose appropriate libraries for interfacing with external sensors, or communication modules.
3. Be versed in different communication standards and technologies. They will be able to choose appropriate communication technology/technologies for designing an IoT system.
4. Be knowledgeable about Medium Access Protocols, routing algorithms and their implementations.
5. Able to compare different IoT systems in terms of different performance metrics: network lifetime, power consumption, reliability of the network etc.
6. Able to design a small-scale IoT system for several real-world applications

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UGEVT605B	**Cyber security**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.

Classification of cyber-crimes, Common cyber-crimes- cyber-crime targeting computers and mobiles, cyber-crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cyber-crimes, Remedial and mitigation measures, Legal perspective of cyber-crime, IT Act 2000 and its amendments, Cyber-crime and offences, Organisations dealing with Cyber-crime and Cyber security in India, Case studies.

Introduction to Social networks. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.

Definition of E- Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best practices, Introduction to digital payments, Components of digital payment and stake holders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled

payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorised banking transactions. Relevant provisions of Payment Settlement Act,2007.

End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third-party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions.

Text/Reference Books:

1. Introduction to Security of Cyber-Physical Systems", by Dr. Jeeva Jose & Vijo Mathew, Khanna Book Publishing Company.
2. Cyber Crime and its Prevention in Easy Steps, Debtoru Chatterjee, Khanna Publishing House.
3. Cyber Attacks and Counter-Measures Made Simple, Debtoru Chatterjee, Khanna Publishing House.
4. Cyber Crime Impact in the New Millennium, by R. C Mishra, Auther Press. Edition 2010. 2. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd. (First Edition, 2011).
5. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform. (Pearson, 13th November, 2001)
6. Electronic Commerce by Elias M. Awad, Prentice Hall of India Pvt Ltd.
7. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K, Dominant Publishers.
8. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition, Wiley India Pvt. Ltd.
9. Fundamentals of Network Security by E. Maiwald, McGraw Hill.
10. Mastering Hacking, Harsh Bothra, Khanna Book Publishing.

Course outline: At the end of this course, students will demonstrate the ability to

1. Understand the concept of Cyber security and issues and challenges associated with it.
2. Understand the cyber-crimes, their nature, legal remedies and as to how report the crimes through available platforms and procedures.
3. Understand various privacy and security concerns on online Social media and understand the reporting procedure of inappropriate content, underlying legal aspects and best practices for the use of Social media platforms.
4. Understand the basic concepts related to E-Commerce and digital payments.
5. Understand the basic security aspects related to Computer and Mobiles. They will be able to use basic tools and technologies to protect their devices.

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UGEVT702A	**Artificial intelligence and machine learning**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Logic and Knowledge Representation - Knowledge base - Ontology - Commonsense Knowledge Representation of Commonsense knowledge – Graphical models – Belief networks - State space representation – Vector representation - Propositional logic and predicate logic - Propositional and predicate logic - Syntax - Informal and formal semantics - Validity, satisfiability - Semantic entailment - Equivalence - De Morgan's laws - Decidable problems - Many-sorted logic - first-order, aspects of higher-order logic.

Automated Reasoning– Formal program techniques: specification by pre- and post-conditions, derivation and verification of programs, invariants. Strategic Reasoning in AI - Agents, strategic behaviours of agents in multiagent systems (MAS) by using the language of alternating-time temporal logic (ATL), an extension of the temporal logics CTL and LTL which allows to express game-theoretical notions such as the existence of a winning strategy for a group of agents - Expert system-based reasoning - Production system, semantic network, and frame - Soft computing based reasoning – Fuzzy logic.

Decision Theory Decision-Making: basics of utility theory, decision theory, sequential decision problems, decision networks, elementary game theory, sample applications; Problem-solving through Search: forward and backward, state-space, blind, heuristic, hill climbing, best-first, A, A*, AO*, minimax, constraint propagation, intelligent search, meta-heuristics, problem-reduction, neural and stochastic; Intelligent agents - reactive, deliberative, goal-driven, utility-driven, and learning agents Artificial Intelligence programming techniques; Planning: planning as search, partial order planning, construction and use of planning graph.

Introduction: Machine learning, Terminologies in machine learning, Types of machine learning: supervised, unsupervised, semi-supervised learning. Discriminative Models: Least Square Regression, Gradient Descent Algorithm, Univariate and Multivariate Linear Regression, Prediction Model, probabilistic interpretation, Regularization, Logistic regression, multi-class classification, Support Vector Machines- Large margin classifiers, Nonlinear SVM, kernel functions, SMO algorithm. Model evaluation and improvement, Regularization, Bias Variance, Hyperparameter Tuning. Computational Learning theory- Sample complexity, exhausted version space, PAC Learning, agnostic learner, VC dimensions, Sample complexity - Mistake bounds.

Gaussian models: Multivariate Gaussian distributions, Maximum Likelihood Estimate, inferring parameters, Mixture models, EM algorithm for clustering and learning with latent variables. Generative models: Linear Discriminative Analysis,Na¨ıve Bayes classifier, Decision trees, Ensemble models – Bagging and Boosting. Unsupervised Learning Algorithms: Dimensionality Reduction Principal Component Analysis (PCA), Singular Value Decomposition (SVD). Clustering – Hierarchical, Partitioned clustering: K-means, PAM, explainable AI (XAI), Approaching an ML problem.

Text/Reference Books:

1. Russell, Norvig, Artificial Intelligence: A Modern Approach, Third edition, Prentice Hall, 2010.
2. M.C. Trivedi, A Classicial Approach to Artificial Intelligence, Khanna Book Publishing Company, 2020.
3. Jeeva Jose, Machine Learning using Python, Khanna Book Publishing Company, 2020.

4. Rajiv Chopra, Simplified Q&A - Data Science with Artificial Intelligence, Machine Learning and Deep Learning, Khanna Book Publishing Company, 2022.
5. Tsang, Foundations of constraint satisfaction, Academic press, 1993.
6. Gendreau, Michel, and Jean-Yves Potvin, Handbook of metaheuristics, Springer, 2010.
7. Tom Mitchell, "Machine Learning", McGraw Hill, 1997
8. E. Alpaydin, "Introduction to Machine Learning", PHI, 2005.
9. Andrew Ng, Machine learning yearning, https://www.deeplearning.ai/machine-learningyearning/
10. AurolienGeron," Hands-On Machine Learning with Scikit-Learn and TensorFlow, Shroff/O'Reilly",2017
11. Andreas Muller and Sarah Guido," Introduction to Machine Learning with Python: A Guide for Data Scientists", Shroff/O'Reilly, 2016
12. Alejandro Barredo Arrieta, Natalia D´ıaz-Rodr´ıguez, Javier Del Ser, et.al.," Explainable Artificial Intelligence (XAI): Concepts, taxonomies, opportunities and challenges toward responsible AI, Information Fusion", Volume 58,2020, Pages 82-115,ISSN 1566-2535, https://doi.org/10.1016/j.inffus.2019.12.012.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand foundation principles, mathematical tools, and program paradigms of AI.
2. Apply intelligent agents for Artificial Intelligence programming techniques.
3. Apply problem solving through search for AI applications.
4. Apply logic and reasoning techniques to AI applications.
5. Develop a good understanding of fundamental principles of machine learning.
6. Formulation of a Machine Learning problem.
7. Develop a model using supervised/unsupervised machine learning algorithms for classification/prediction/clustering.
8. Evaluate performance of various machine learning algorithms on various data sets of a domain.
9. Design and Concrete implementations of various machine learning algorithms to solve a given problem using languages such as Python.

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UGEVT605A	**Quantum Computing**	**3L:0T:0P**	**3 credits**

Detailed Contents:

Review of Quantum Mechanics and Motivation for Quantum Computation Qubit: The qubit state - matrix and Bloch sphere representation - computational basis unitary evolution.

Multi-qubit states - No-cloning theorem - Superdense coding - Pure states to Bell states – Bell

inequalities. Protocols with multi-qubits: Swapping - Teleportation - gates: CNOT - Toffoli gate - NAND - FANOUT - Walsh Hadamard.

Measurement: Projective operators - General, Projective and POVM measure, Ensemble: Density operators - pure and mixed ensemble - time evolution – post measurement density operator. Composite systems: Partial trace - Reduced density operator - Schmidt decomposition, Purification- bipartite entanglement.

Quantum computing: Classical computing using qubits - Quantum parallelism - Deutsch's algorithm -Deutsch Josza algorithm.

Quantum circuits: Basic gates - ABC decomposition - Gray codes - Universal gates - Principle of deferred and implicit measurements - Quantum Fourier transform - applications: phase estimation, order finding - factoring, discrete logarithm and hidden subgroup problems - Role of prime factoring in classical cryptography - search algorithms.

Quantum error correcting codes, Physical realization of qubits.

Text/Reference Books:

1. Quantum Computation and Quantum Information, M. A. Nielsen and I. L. Chuang, Cambridge University Press
2. Quantum Information and Computation, CIT Lecture Notes by J. Preskill.
3. Quantum Theory: Concepts and Methods, Asher Peres, Kluwer Academic Publishers.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Students would learn the framework of quantum computation, and how that may be useful for future quantum technologies.

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UGEVT704C (OE3)	**Algorithms for VLSI**	**3L:0T:0P**	**3 credits**

Course outcomes: At the end of the course the student should be able to:
CO1. Understand Different aspects of Algorithms: Complexity, Notations, and Analysis.
CO2. Understand and apply graph minimisation algorithms on VLSI netlists in Structural Design.
CO3. Write code for algorithms used in computational and geometrical simplification and optimisation using data structures for CAD tools.
CO4. Understand and write code for partitioning, floor planning, chip planning, pin assignment, Placement and

Routing during the physical design of a chip.
CO5. Apply optimisation algorithms in various VLSI Design steps, including Hardware Security.
***Prerequisite**: Concept of Programming, mathematical concepts such as: Logarithms, Graph Theory.*

Course content:

Module 1: Introduction to Algorithms (8): Concept of Algorithm, The role of algorithm in computing, Fundamentals of Algorithm, Important Types of Algorithm, Fundamental Data Structures. Introduction Analysis Framework, Methodologies for Analyzing Algorithms, Amortization, and Case Studies in Algorithm Analysis. Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non recursive Algorithms. Mathematical Analysis of Recursive Algorithms, empirical Analysis of Algorithms, Algorithm visualization.

Module 2: Graph Algorithms (5): Graph search Algorithms, Spanning tree Algorithm, Shortest path Algorithm, Matching Algorithm, Min cut and Max cut Algorithms and Steiner Tree Algorithm.

Module 3: NP-Complete Problem (7): NP-class of problems, P-class problems, NP=P question, Polynomial problem reduction (Reducibility), Cook's theorem, NP-hardness and NP-completeness, NP-completeness FAQ including how to handle NP-hard problems, Examples of NP-completeness proofs: SAT to 3-SAT, Polynomial-time non-deterministic algorithms, Maximum Clique Problem.

Module 4: High Level Synthesis (8): Steps of VLSI Design flow, Steps of High Level Synthesis. Data Dependency graph. Scheduling Algorithms, Allocation and binding: Conflict Graph, Compatibility Graph, left Edge Algorithm, Data path and Controller Synthesis. Secure Design with HLS: different methods of obfuscation. Logic level Synthesis. Line sweep method. Graph Algorithms for physical design: Classes of graphs in physical design, relationship between graph classes, graph problems, Algorithms for interval graphs.

Module 5: Partitioning, Placement, and Routing Algorithms (8):
Partitioning: Group migration Algorithms. Floor planning and Pin assignment: Slicing, Non-Slicing.
Placement: Simulated annealing, simulated evolutions, force directed placement, sequence pair technique.
Routing: Routing Algorithms. Shortest path algorithm, Steiner tree based Algorithm. Single layer routing Algorithms and two layer routing Algorithms. Over the cell routing, Via minimization, clock, power and ground routing. Topological Sort.

Suggested books

1. Naveed Sherwani, "Algorithms for VLSI Physical Design Automation" 3 rd edition, Springer international, 1998.
2. Pinaki Mazumber, Elizabeth M Rudnick, "Genetic Algorithms For VLSI Design, Layout & Test Automation", Pearson education, 2007.
3. Ellis Horowitz, sartajsahni, Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms" Universities Press.
4. Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, "Introduction to Algorithms", 4TH Edition, MIT Press/McGraw-Hill.

Suggested references

1. Jon Kleinberg and ÉvaTardos, "Algorithm Design", 1ST Edition, Pearson.
2. Michael T Goodrich and Roberto Tamassia, "Algorithm Design: Foundations, Analysis, and Internet Examples", Second Edition, Wiley.
3. Udi Manber, Addison-Wesley, "Algorithms -- A Creative Approach", 3RD Edition, Addison-Wesley

Publishing Company.
4. “C-Based VLSI Design” lecture note of prof. Chandan Karfa, IIT Guahati.

CO-PO Mapping

CO	BL	Course Outcomes	Program Outcomes											
			1	2	3	4	5	6	7	8	9	10	11	12
1.	2	Understand Different aspects of Algorithms: Complexity, Notations, and Analysis.	1	2	3	1	1	1	0	0	1	0	0	3
2.	2	Understand and apply graph minimization algorithms on VLSI net lists in Structural Design.	2	3	3	3	3	1			1	0	0	3
3.	2	Write code for algorithms used in computational and geometrical simplification and optimization using data structures for CAD tools.	2	3	3	3	3	1			1	0	0	3
4.	3	Understand and write code for partitioning, floor planning, chip planning, pin assignment, Placement and Routing during the physical design of a chip.	3	3	3	3	3	1			1	0	0	3
5.	3	Apply optimization algorithms in various VLSI Design steps, including Hardware Security.	3	3	3	3	3	1			1	0	0	3
Average			2	3	3	3	3	1	0	0	1	0	0	3