COURSE SCHEME AND SYLLABUS

FOR

B.E. (ELECTRICAL ENGINEERING)

THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

2025-2029

Approved in 3rd meeting of the Academic Council held on 18th March, 2026

SEMESTER-I

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UPH013	PHYSICS	BSC	3	1	2	4.5
2.	UES101	ENGINEERING DRAWING	ESC	2	4	0	4.0
3.	UHU003	PROFESSIONAL COMMUNICATION	HSS	2	0	2	3.0
4.	UMA022	CALCULUS FOR ENGINEERS	BSC	3	1	0	3.5
5.	UES102	MANUFACTURING PROCESSES	ESC	2	0	2	3.0
6.	UTA032	BOOT CAMP		0	0	0	1.0*
		TOTAL		**12**	**6**	**6**	**19.0**

SEMESTER-II

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UCB009	CHEMISTRY	BSC	3	0	2	4.0
2.	UES103	PROGRAMMING FOR PROBLEM SOLVING	ESC	3	0	2	4.0
3.	UES013	ELECTRICAL & ELECTRONICS ENGINEERING	ESC	3	1	2	4.5
4.	UEN008	ENERGY AND ENVIRONMENT	HSS	2	0	0	2.0
5.	UMA023	DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA	BSC	3	1	0	3.5
		TOTAL		**14**	**2**	**6**	**18.0**

Cumulative Credits:37

SEMESTER-III

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UMA028	MATHEMATICS FOR DATA SCIENCE	BSC	3	0	2	4.0
2.	UEE307	TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER	PCC	2	1	0	2.5
3.	UEE301	DIRECT CURRENT MACHINES AND TRANSFORMERS	PCC	3	1	2	4.5
4.	UES302	INTRODUCTION TO MEASUREMENT SYSTEMS	ESC	2	0	2	3.0
5.	UTA030	ENGINEERING DESIGN PROJECT (BUGGY)	PRJ	1	0	4	3.0
6.	UTD003	APTITUDE SKILLS BUILDING	HSS	2	0	0	2.0
7.	UCS321	AI FOR ENGINEERS	ESC	2	0	2	3.0
		TOTAL		15	2	12	**22.0**

Cumulative Credits:59

SEMESTER-IV

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UEE401	ALTERNATING CURRENT MACHINES	PCC	3	1	2	4.5
2.	UTA018	OBJECT ORIENTED PROGRAMMING	ESC	3	0	2	4.0
3.	UEE409	NETWORK THEORY	PCC	3	1	2	4.5
4.	UEE412	ANALOG AND DIGITAL CIRCUITS	PCC	3	0	2	4.0
5.	UMA035	OPTIMIZATION TECHNIQUES	BSC	3	0	2	4.0
6.	UHU052	THE EVOLUTIONARY BASIS OF HUMAN BEHAVIOUR FOR ENGINEERS (1 SELF EFFORT HOUR)	HSS	1*	0	0	1.0

7.	UCS421	ETHICS AND RISK MITIGATION IN AI	ESC	3	0	0	3.0
		TOTAL		17+1*	2	10	**25.0**

*****Alternate Week

Cumulative Credits:84

SEMESTER-I

UPH013: Physics

	L	T	P	Cr
	3	1	2	4.5

Course Objective: To introduce the student to the basic physical laws of oscillators, acoustics of buildings, ultrasonics, electromagnetic waves, wave optics, lasers, and quantum mechanics and demonstrate their applications in technology. To introduce the student to measurement principles and their application to investigate physical phenomena

Syllabus

Oscillations and Waves: Oscillatory motion and damping, Applications - Electromagnetic damping – eddy current; ***Acoustics:*** Reverberation time, absorption coefficient, Sabine's and Eyring's formulae (Qualitative idea), Applications - Designing of hall for speech, concert, and opera; ***Ultrasonics:*** Production and Detection of Ultrasonic waves, Applications - green energy, sound signaling, dispersion of fog, remote sensing, Car's airbag sensor.

Electromagnetic Waves: Scalar and vector fields; Gradient, divergence, and curl; Stokes' and Green's theorems; Concept of Displacement current; Maxwell's equations; Electromagnetic wave equations in free space and conducting media, Application - skin depth.

Optics: ***Interference:*** Parallel and wedge-shaped thin films, Newton rings, Applications as Non-reflecting coatings, Measurement of wavelength and refractive index. ***Diffraction:*** Single and Double slit diffraction, and Diffraction grating, Applications - Dispersive and Resolving Powers. ***Polarization:*** Production, detection, Applications – Anti-glare automobile headlights, Adjustable tint windows. ***Lasers:*** Basic concepts, Laser properties, Ruby, HeNe, and Semiconductor lasers, Applications – Optical communication and Optical alignment.

Quantum Mechanics: Wave function, Steady State Schrodinger wave equation, Expectation value, Infinite potential well, Tunneling effect (Qualitative idea), Application - Quantum computing.

Laboratory Work

1. Determination of damping effect on oscillatory motion due to various media.
2. Determination of velocity of ultrasonic waves in liquids by stationary wave method.
3. Determination of wavelength of sodium light using Newton's rings method.
4. Determination of dispersive power of sodium-D lines using diffraction grating.
5. Determination of specific rotation of cane sugar solution.
6. Study and proof of Malus' law in polarization.
7. Determination of beam divergence and beam intensity of a given laser.
8. Determination of displacement and conducting currents through a dielectric.

9. Determination of Planck's constant.

Micro Project:
Students will be given physics-based projects/assignments using computer simulations, etc.

Course Learning Objectives (CLO)
The students will be able to:

1. understand damped and simple harmonic motion, the role of reverberation in designing a hall and generation and detection of ultrasonic waves.
2. use Maxwell's equations to describe propagation of EM waves in a medium.
3. demonstrate interference, diffraction and polarization of light.
4. explain the working principle of Lasers.
5. use the concept of wave function to find probability of a particle confined in a box.
6. perform an experiment, collect data, tabulate and report them and interpret the results with error analysis.

Text Books

1. Beiser, A., Concept of Modern Physics, Tata McGraw Hill (2007) 6th ed.
2. Griffiths, D.J., Introduction to Electrodynamics, Prentice Hall of India (1999) 3rd ed.
3. Jenkins, F.A. and White, H.E., Fundamentals of Optics, McGraw Hill (2001) 4th ed.

Reference Books

1. Wehr, M.R, Richards, J.A., Adair, T.W., Physics of The Atom, Narosa Publishing House (1990) 4th ed.
2. Verma, N.K., Physics for Engineers, Prentice Hall of India (2014)1st ed.
3. Pedrotti, Frank L., Pedrotti, Leno S., and Pedrotti, Leno M., Introduction to Optics, Pearson Prentice HallTM (2008) 3rd ed.

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UES101: Engineering Drawing				
	L	T	P	Cr
	2	4	0	4.0

Course Objective: This module is dedicated to graphics and includes two sections: 2D drafting and 3D modelling of solid objects. This course is aimed at making the student understand the concepts of projection systems, learn how to create projections of solid objects using first and third angle orthographic projection as well as isometric and auxiliary projection, concept of sectioning, to interpret the meaning and intent of toleranced dimensions and to create/edit drawings using drafting software. In addition, this course shall give an insight on the basic 3D modelling concepts like extrude, revolve, sweep, construction of complex solids.

Syllabus

Engineering Drawing Concepts

1. Introduction to Engineering Drawing
2. Projection systems: First angle and third angle projection system
3. Orthographic Projection: Points, Lines, Solid objects
4. Isometric Projections
5. Auxiliary Projections
6. Development of surfaces
7. Section of solids
8. Limits, fits and tolerances

2D Drafting

1. Management of screen menus commands
2. Creating basic drawing entities
3. Co-ordinate systems: Cartesian, polar and relative coordinates
4. Drawing limits, units of measurement and scale
5. Layering: organizing and maintaining the integrity of drawings
6. Design of prototype drawings as templates.
7. Editing/modifying drawing entities: selection of objects, object snap modes, editing commands,
8. Dimensioning: use of annotations, dimension types, properties and placement, adding text to
drawing

3D Modelling

1. Management of screen menus commands
2. Introduction to basic 3D modelling commands such as extrude, revolve, sweep etc.
3. Creation of 2D drawings from a 3D model

Micro Projects /Assignments:

1. Completing the views - Identification and drawing of missing lines and views in the projection of objects

2. Projects related to orthographic and isometric projections Using wax blocks/soap bars/any soft material to develop three dimensional object from given orthographic projections

3. a. 3D modelling of complex machine components
   b. Development of production drawings of individual components from the model

Course Learning Objectives (CLO)

The students will be able to:

1. creatively comprehend the geometrical details of common engineering objects
2. draw dimensioned orthographic and isometric projections of simple engineering objects
3. interpret the meaning and intent of limits, fits and tolerances in the drawing
4. create/edit the engineering drawings for simple engineering objects using 2D drafting software
5. create/edit 3D models of engineering components using 3D modelling software

Text Books

1. Jolhe, D.A., Engineering Drawing, Tata McGraw Hill, 2008
2. Davies, B. L., Yarwood, A., Engineering Drawing and Computer Graphics, Van Nostrand Reinhold (UK), 1986

Reference Books

1. Gill, P.S., Geometrical Drawings, S.K. Kataria & Sons, Delhi (2008).
2. Gill, P.S., Machine Drawings, S.K. Kataria & Sons, Delhi (2013).
3. Mohan, K.R., Engineering Graphics, Dhanpat Rai Publishing Company (P) Ltd, Delhi (2002).
4. French, T. E., Vierck, C. J. and Foster, R. J., Fundamental of Engineering Drawing & Graphics Technology, McGraw Hill Book Company, New Delhi (1986).
5. Rowan, J. and Sidwell , E. H., Graphics for Engineers, Edward Arnold, London (1968).
6. Mastering AutoCAD 2021 and AutoCAD LT 2021, Brian C. Benton, George Omura, Sybex - John Wiley and Sons, Indiana (2021).

Evaluation Scheme

Course Component	**Weightage**
AutoCAD tutorials/SolidWorks/Project work*	35
MST (1.5 hours-CAD based)**	20
EST (2 hours-CAD based)**	45

***Students are required to bring their personal computers for the** tutorial work.*
**Availability of institute server resources for sharing the software licences with the student*

community.
***Institute computational resources in collaboration with other academic units / departments for conducting the mid semester and end semester test.*

UHU003: Professional Communication

L	T	P	Cr
2	0	2	3.0

Course Objective: The course is designed to develop the interpersonal, written, and oral as well as the non- verbal communication skills of the students. The course begins by building up on the theoretical concepts and then practicing on the applicability of the various elements. Since the course has very high applicability content, the students are advised to practice in class as well as off class. A very high level of interaction is expected of the students in the class.

Syllabus

Fundamentals of Communication: Meaning, Types and Characteristics of communication, Applicability of Transactional Analysis and Johari Window for enhancing interpersonal communication skills. Seven Cs of Effective Communication, Barriers to Effective Communication.

Effective Oral Communication: Understanding Principles of Oral communication, Formal and Informal Oral Communication, Oral Communication and Behavioral Patterns, Advantages and Disadvantages of Oral Communication.

Effective Listening: Listening vs Hearing, Active Listening techniques, Barriers to Listening.

Effective non-verbal communication: Meaning and Importance of Non-Verbal Communication, Different Types of Non-verbal Communication, Interpretation of Non-verbal Cues.

Effective written Communication: Characteristics of Good Writing, Choice of Words, Sentence Construction, Paragraph development, Forms of writing.

Business Communication: Technical Report Writing, Designing Resumes and Cover Letters for effective job application, E-mail writing and e-mail etiquette.

Organizational Communication: Directional communication: Downward, Upward and Horizontal Communication, Grapevine.

Reading: The following texts (one from each of the two categories listed below) are required to be read by the students in the semester:
Category 1: Animal Farm by George Orwell, Lord of the Flies by William Golding, Life of Pi by Yann Martel
Category 2: The Namesake by Jhumpa Lahiri, The God of Small Things by Arundhati Roy, Q&A by Vikas Swarup

Laboratory Work

1. Needs-assessment of spoken and written communication with feedback.

2. Training for Group Discussions through simulations and role plays.
3. Technical report writing on survey-based projects.
4. Project-based team presentations.

Course Learning Objectives (CLO)

The students will be able to:

1. Apply communication concepts for effective interpersonal communication.
2. Speak assertively and effectively.
3. Interpret non-verbal cues in professional communication.
4. Write objectively, purposefully and effectively.
5. Design effective resumes and reports.

Text Books

1. Mukherjee H.S..Business Communication: Connecting at Work. Oxford University Press.(2013)
2. Lesikar R.V, and Flately M.E., Basic Business Communication Skills for empowering the internet generation.(2006)
3. Raman, M.,and Singh ,P, Business Communication . Oxford . University Press (2008).

Reference Books

1. Riordan, G.R. Technical Communication. Cengage Learning India Private Ltd. (2012)
2. Butterfield, Jeff., Soft Skills for everyone, Cengage Learning New Delhi, (2013).
3. Robbins, S.P., & Hunsaker, P.L., Training in Interpersonal Skills, Prentice Hall of India, New Delhi, (2008).
4. Orwell, G., Animal Farm, Fingerprint Publishing, New Delhi, (2017).
5. Golding, W, Lord of the Flies, Faber & Faber; Export edition (1999)
6. Martel,Y., Life of Pi, RHC, New Delhi, (2012).
7. Lahiri,J., The Namesake, Harpercollins (2007)
8. Arundhati Roy,A., The God of Small Things, Penguin India, (2002).
9. Swarup,V., Q&A, Black Swan,(2009).

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following)	30

	Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	

UMA022: CALCULUS FOR ENGINEERS

L	T	P	Cr
3	1	0	3.5

Course Objective: To provide students with skills and knowledge in sequence and series, advanced calculus, calculus of several variables and complex analysis which would enable them to devise solutions for given situations they may encounter in their engineering profession.

Syllabus

Sequences and Series: Introduction to sequences and infinite series, Tests for convergence/divergence, Limit comparison test, Ratio test, Root test, Cauchy integral test, Alternating series, Absolute convergence, and conditional convergence.

Series Expansions: Power series, Taylor series, Convergence of Taylor series, Error estimates, Term by term differentiation and integration.

Partial Differentiation: Functions of several variables, Limits and continuity, Chain rule, Change of variables, Partial differentiation of implicit functions, Directional derivatives and its properties, Maxima and minima by using second order derivatives.

Multiple Integrals: Double integral (Cartesian), Change of order of integration in double integral, Polar coordinates, Graphing of polar curves, Change of variables (Cartesian to polar), Applications of double integrals to areas and volumes, Evaluation of triple integral (Cartesian).

Complex analysis: Introduction to complex numbers, Geometrical interpretation, Functions of complex variables, Examples of elementary functions like exponential, trigonometric and hyperbolic functions, Elementary calculus on the complex plane (limits, continuity, differentiability), Cauchy – Riemann equations, Analytic functions, Harmonic functions.

Course Learning Objectives (CLO)

The students will be able to:

1. determine the convergence/divergence of infinite series, approximation of functions using power and Taylor's series expansion and error estimation.
2. examine functions of several variables, define and compute partial derivatives, directional derivatives, and their use in finding maxima and minima in some engineering problems.
3. evaluate multiple integrals in Cartesian and Polar coordinates, and their applications to engineering problems.
4. represent complex numbers in Cartesian and Polar forms and test the analyticity of complex functions by using Cauchy – Riemann equations.

Text Books

1. Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry, Pearson Education (2007), 9th ed.
2. Stewart James, Essential Calculus; Thomson Publishers (2007), 6th ed.
3. Kasana, H.S., Complex Variables: Theory and Applications, Prentice Hall India, 2005 (2nd edition).

Reference Books

1. Wider David V, Advanced Calculus: Early Transcendentals, Cengage Learning (2007).
2. Apostol Tom M, Calculus, Vol I and II, John Wiley (2003).
3. Brown J.W and Churchill R.V, Complex variables and applications, McGraw Hill, (7th edition)

Evaluation Scheme

Sr. No.	**Evaluation elements**	**Weightage (%)**
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UES102: Manufacturing Processes

L	T	P	Cr
2	0	2	3.0

Course Objective: This course introduces the basic concepts of manufacturing via machining, forming, casting and joining, enabling the students to develop a basic knowledge of the mechanics, operation and limitations of basic machining tools along with metrology and measurement of parts. The course also introduces the concept of smart manufacturing.

Syllabus

Machining Processes: Principles of metal cutting, Cutting tools, Cutting tool materials and applications, Geometry of single point cutting tool, Introduction to computerized numerical control (CNC) machines, G and M code programming for simple turning and milling operations, introduction of canned cycles.

Metal Casting: Introduction & Principles of sand casting, Requisites of a sound casting, Permanent mold casting processes, casting defects

Metal Forming: Hot & cold metal working, Forging, Rolling, Sheet Metal operations.

Joining Processes: Method of joining, type of electric arc welding processes, Methods of shielding, Power source characteristics, Resistance welding, Soldering, Brazing.

Smart Manufacturing: IoT and ML in manufacturing, Introduction to Additive Manufacturing, Robotics and Automation in manufacturing.

Laboratory Work

Relevant shop floor exercises involving practices in Sand casting, Machining, Welding, Sheet metal fabrication techniques, CNC turning and milling exercises, Experiments on basic engineering metrology and measurements to include measurements for circularity, ovality, linear dimensions, profiles, radius, angular measurements, measurement of threads, surface roughness.

Basic knowledge and derivations related to above measurements, uncertainties, statistical approaches to estimate uncertainties, Line fitting, static and dynamic characteristics of instruments will be discussed in laboratory classes.

Assignments: Assignments for this course will include the topics: Manufacturing of micro-chips used in IT and electronics industry and use of touch screens. Another assignment will be given to practice numerical exercises on topics listed in the syllabus. Case study related to smart manufacturing.

Micro Project: Fabrication of multi-operational jobs using the above processes as per requirement by teams consisting of 4 -6 members. Quality check should be using the equipment available in metrology lab.

Course Learning Objectives (CLO)

The students will be able to:

1. identify & analyse various machining processes/operations for manufacturing of industrial components
2. apply the basic principle of bulk and sheet metal forming operations
3. apply the knowledge of metal casting for different requirements.
4. identify and analyse the requirements to for achieving a sound welded joint apply the concept of smart manufacturing

Text Books

1. Degarmo, E. P., Kohser, Ronald A. and Black, J. T., Materials and Processes in Manufacturing, Prentice Hall of India (2008) 8th ed.
2. Kalpakjian, S. and Schmid, S. R., Manufacturing Processes for Engineering Materials, Dorling Kingsley (2006) 4th ed.

Reference Books

1. Martin, S.I., Chapman, W.A.J., Workshop Technology, Vol.1 & II, Viva Books (2006) 4th ed.
2. Zimmer, E.W. and Groover, M.P., CAD/CAM - Computer Aided Designing and Manufacturing, Dorling Kingsley (2008).
3. Pandey, P.C. and Shan, H. S., Modern Machining Processes, Tata McGraw Hill (2008).
4. Mishra, P. K., Non-Conventional Machining, Narosa Publications (2006).
5. Campbell, J.S., Principles of Manufacturing, Materials and Processes, Tata McGraw Hill Company (1999).
6. Lindberg, Roy A., Processes and Materials of Manufacture, Prentice Hall of India (2008) 4th ed.

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

SEMESTER-II

UCB009: Chemistry

L	T	P	Cr
3	0	2	4.0

Course Objective: The course aims at elucidating principles of applied chemistry in industrial systems, water treatment, engineering materials, computational and analytical techniques.

Syllabus

Atomic and Molecular spectroscopy: Introduction to spectroscopy, principles of atomic absorption, flame emission spectrophotometry and ICP-AES (Inductively Coupled Plasma- Atomic Emission Spectroscopy), Quantification by calibration method, Jablonski diagram, fluorescence and phosphorescence, Beer-Lambert's Law, principle and applications of UV-Vis and IR spectroscopy.

Electrochemistry: Background of electrochemistry, Ionic mobility, Conductometric titrations, Modern Batteries: Pb-acid and Li ion battery, Corrosion and its protection.

Water Treatment and Analysis: Physiochemical parameters of water quality, External and internal methods of Softening of water: carbonate, phosphate, calgon and colloidal conditioning, Zeolite process, Ion exchange process, treatment of water for domestic use, Desalination of brackish water: Reverse osmosis & Electrodialysis.

Fuels: Classification of fuels, Calorific value, Cetane and Octane number, alternative fuels: biodiesel, Power alcohol, synthetic petrol, Fuel cells: H2 production and storage, Water splitting, Rocket propellant.

Chemistry of Polymers: Classification of polymers, tacticity of polymers, molecular weight calculations, Polymers in daily life, conducting, inorganic and biodegradable polymers.

Computers in Chemistry: Introduction to SMILES (Simplified Molecular Input Line-Entry System): Methodology and encoding rules, SMILES notation-chemical structure interconversions and its applications.

Laboratory Work

Electrochemical measurements: Experiments involving use of pH meter, conductivity meter, potentiometer, Spectroscopic technique, Volumetric titrations: Determination of mixture of bases, hardness, alkalinity, chloride and iron content, Application of polymers and SMILES Language.

Course Learning Objectives (CLO)

The students will be able to:

1. recognize principles and applications of atomic and molecular spectroscopy.
2. explain the concepts of conductometric titrations, modern batteries and corrosion.
3. apply and execute water quality parameter and treatment methods.
4. discuss the concept of alternative fuels, application of polymers and SMILES.
5. execute laboratory techniques like pH metry, potentiometry, spectrophotometry, conductometry and volumetry.

Text Books

1. Engineering Chemistry, S. Vairam and S. Ramesh, Wiley India 1st ed, 2014.
2. Engineering Chemistry, K. S. Maheswaramma, and M. Chugh. Pearson, 2016.

Reference Books

1. Engineering Chemistry, B. Sivasankar, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 2008.
2. Engineering Chemistry, M.J. Shulz, Cengage Learnings, 2007.
3. J. Chem. Inf. Comput. Sci., D. Weininger, Vol. 28, 1988, 31-36.

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UES103: Programming for Problem Solving

L	T	P	Cr
3	0	2	4.0

Course Objectives: This course is designed to solve and explore the problems using the art of computer programming with the help of C Language. Students will be able to apply these problem solving concepts in real life applications.

Syllabus

Introduction to Computer Fundamentals- Computer Memory Hierarchy, Types of Software Binary number system, Algorithm, Flowchart, Formulate simple algorithms for logical and arithmetic problems.

Basics of C Programming: Structure and Life cycle of a C Program, Data types, Identifiers, Variables, Keywords, Constants, input/output statements, Operators, Type conversion and type casting. Translate the algorithms to code snippets.

Decision Making and Iterative Statements- Decision making- if, if-else, Nested if-else, Multiple if, else if, switch, Ternary Operator, **Loops-** (while, do-while, for), Nesting of Loops, break, continue and goto. Implement the switch () to solve the basic functions of scientific calculator.

Functions: Function prototype, Definition and Call, Type of Functions, Scope of variables in (Block, Function, Program, File), Storage classes (Auto, Register, Static and Extern), Recursion (with the introduction of Stack), Implementation of recursion to solve the problem of Tower of Hanoi.

Arrays and Strings- One-dimensional array its operations (Traversal, Linear Search, Insertion, Deletion, Bubble Sort), Two-dimensional and its operations (Addition, Transpose and Multiplication), Passing of array into a function (row and entire array), Input and output of a string, string inbuilt functions, 2-D Character array.

Pointers: Introduction to Pointers, Pointer arithmetic, Passing arguments to a function using pointer (understanding of call by value and call by reference), Accessing arrays using pointers Dynamic memory allocation (malloc(), calloc(), realloc() and free()), Pointer and Functions.

Structures and Union: Structure declaration, Initialization of structures, Structure variables, Accessing structure elements using (.) operator, Array of structure variables, Passing structure variable to a function (individual and entire structure), Structure pointer, Comparison of Structure and Union.

File Handling: Introduction of Files (streams in C), using File (Declaring, Opening and Closing), Operations on File (Reading, Writing and appending), and Random Access of a file, command line argument.

Laboratory Work

To implement programs for various kinds of real life applications in C Language.

Course Learning Outcomes (CLOs) /Course Objectives (COs):

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

1. Comprehend and analyze the concepts of number system, memory, compilation and debugging of the programs in C language.
2. Analyze the control & iterative statements to solve the problems with C language source codes.
3. Design and create programs for problem solving involving arrays, strings and pointers.
4. Evaluate and analyze the programming concepts based on user define data types and filehandling using C language.

Text Books

1. C Programming Language, Brian W. Kernighan Dennis M. Ritchie, 2nd ed, 2012.
2. Programming in ANSI C, Balagurusamy G., 8th ed., 2019

Reference Books

1. Let Us C, Kanetkar Y., 16th ed., 2017
2. Programming with C, Byron S Gottfried, McGraw Hill Education, Forth edition, 2018

<UES013> : <Electrical and Electronics Engineering>				
	L	T	P	Cr
	3	1	2	4.5

Course Objective: To introduce the basic concepts of electrical and electronics engineering.

Syllabus

Unit 1: DC Circuits: Introduction to circuit elements; independent and dependent current and voltage sources; Kirchhoff's laws; mesh and node analysis; source transformations; network theorems: Superposition theorem, Thevenin's and Norton's theorem, Maximum power transfer theorem; star-delta transformation; transient response of R-L and R-C circuits.

Unit 2: AC Circuits & Magnetic circuits: Concept of phasor, phasor representation of circuit elements; analysis of series and parallel AC circuits; concept of real, reactive and apparent powers; resonance in RLC series circuits; balanced three phase circuits: voltage, current and power relations for star and delta arrangement; three phase power measurement using two-wattmeter method; Analogy between electric and magnetic circuits; series and parallel magnetic circuits; equivalent inductances; single-phase transformer.

Unit 3: Digital Logic Design: Number systems, Positive and negative representation of numbers, Signed-number representation, Binary arithmetic, Postulates and theorems of Boolean Algebra, Algebraic simplification, Sum of products and product of sums formulations (SOP and POS), Logic Gates and Universal Gates, Minimization of logic functions, Karnaugh Maps, Logic implementation using Gates, Adder, Decoder, MUX, Flip-Flops.

Unit 4: Electronic Devices & Operational Amplifier Circuits: p- n junction diode: V-I characteristics of diode, Operation of Bipolar Junction Transistor, CB and CE configuration, Transistor as a switch; The ideal operational amplifier, the inverting, non-inverting amplifiers, Op-Amp Characteristics, Applications of Op-amp: summing amplifier, differentiator and integrator.

Laboratory Work: Kirchhoff's laws, network theorems, ac series and parallel circuit, three phase power measurement, magnetic circuit, tests on transformer, resonance in AC circuit, combinational circuits, flip flops, shift register and binary counters, asynchronous and synchronous up/down counters, BJT characteristics.

Course Learning Outcomes (CLO)

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

1. Apply various networks laws and theorems to solve dc circuits
2. Compute different ac quantities with phasor representation
3. Comprehend the operation in magnetic circuits, single phase transformer and rotating machines
4. Recognize and apply the number systems and Boolean algebra.
5. Reduce and simplify Boolean expressions and implement them with logic gates.
6. Discuss and explain the working of diode, transistor and operational amplifier, their configurations and applications.

Text Books

1. Hughes, E., Smith, I.M., Hiley, J. and Brown, K., Electrical and Electronic Technology, Prentice Hall (2008) 10th ed.
2. Nagrath, I.J. and Kothari, D.P., Basic Electrical Engineering, Tata McGraw Hill (2002).
3. Boylestad, R.L. and Nashelsky, L., Electronic Devices & Circuit Theory, Perason (2009).
4. Mano M. M. and Ciletti, M.D., Digital Design, Pearson, Prentice Hall, (2013).

Reference Books

1. Chakraborti, A., Basic Electrical Engineering, Tata McGraw−Hill (2008).
2. Del Toro, V., Electrical Engineering Fundamentals, Prentice−Hall of India Private Limited (2004).
3. David Bell, Electronics Devices and Circuits, Oxford Publications (2009).

UEN008: Energy and Environment

L	T	P	Cr
2	0	0	2.0

Course Objective: The exposure to this course would facilitate the students in understanding the terms, definitions and scope of environmental and energy issues pertaining to current global scenario; understanding the need of sustainability in addressing the current environmental & energy challenges.

Syllabus

Introduction: Concept of sustainability and sustainable use of natural resources, Climate Change & its related aspects.

Air Pollution: Origin, Sources and effects of air pollution; Primary and secondary meteorological parameters; wind roses; Atmospheric stability; Source reduction and Air Pollution Control Devices for particulates and gaseous pollutants in stationary sources.

Water Pollution: Origin, Sources of water pollution, Category of water pollutants, Physicochemical characteristics, Components of wastewater treatment systems.

Solid waste management: Introduction to solid waste management, Sources, characteristics of municipal solid waste, Solid waste management methods: Incineration, composting, landfilling.

Energy Resources: Classification of Energy Resources; Non-conventional energy resources- Biomass energy, Thermo-chemical conversion and biochemical conversion route; Solar energy-active and passive solar energy absorption systems; Type of collectors; Thermal and photo conversion applications.

Course Learning Objectives (CLO)
The students will be able to:

1. comprehend the interdisciplinary context of environmental issues with reference to sustainability
2. assess the impact of anthropogenic activities on the various elements of environment and apply suitable techniques to mitigate their impact.
3. demonstrate the application of technology in real time assessment and control of pollutants.
4. correlate environmental concerns with the conventional energy sources associated and assess the uses and limitations of non-conventional energy technologies

Text Books

1. Moaveni, S., Energy, Environment and Sustainability, Cengage (2018)
2. Rajagopalan, R., Environmental Studies, Oxford University Press (2018)

3. O'Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).

Reference Books

1. Peavy H.S., Rowe D.S., and Tchobanoglous, G. (2013) Environmental Engineering, McGraw Hill.
2. Rao, M.N. and Rao, H.V.N. (2014) Air Pollution, McGraw Hill.
3. Metcalf and Eddy. (2003) Wastewater Engineering: Treatment and Reuse, Fourth Edition, McGraw Hill.
4. Rai, G.D. (2014) Non-conventional Energy Resources, Khanna Publishers.

Evaluation Scheme

Sr. No.	**Evaluation elements**	**Weightage (%)**
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UMA023: DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA

L	T	P	Cr
3	1	0	3.5

Course Objective: To introduce students the theory and concepts of differential equations, linear algebra, Laplace transformations and Fourier series which will equip them with adequate knowledge of mathematics to formulate and solve problems analytically.

Syllabus

Ordinary Differential Equations: Review of first order differential equations, Exact differential equations, Second and higher order differential equations, Solution techniques using one known solution, Cauchy - Euler equation, Method of undetermined coefficients, Variation of parameters method, Engineering applications of differential equations.

Laplace Transform: Definition and existence of Laplace transforms and its inverse, Properties of the Laplace transforms, Unit step function, Impulse function, Applications to solve initial and boundary value problems.

Fourier Series: Introduction, Fourier series on arbitrary intervals, Half range expansions, Applications of Fourier series to solve wave equation and heat equation.

Linear Algebra: Row reduced echelon form, Solution of system of linear equations, Matrix inversion, Linear spaces, Subspaces, Basis and dimension, Linear transformation and its matrix representation, Eigen-values, Eigen-vectors and Diagonalisation, Inner product spaces and Gram-Schmidt orthogonalisation process.

Course Learning Objectives (CLO)

The students will be able to:

1. solve the differential equations of first and 2nd order and basic application problems described by these equations.
2. find the Laplace transformations and inverse Laplace transformations for various functions. Using the concept of Laplace transform students will be able to solve the initial value and boundary value problems.
3. find the Fourier series expansions of periodic functions and subsequently will be able to solve heat and wave equations.
4. solve systems of linear equations by using elementary row operations.
5. identify the vector spaces/subspaces and to compute their bases/orthonormal bases. Further, students will be able to express linear transformation in terms of matrix and find the eigenvalues and eigenvectors.

Text Books

1. Simmons, G.F., Differential Equations (With Applications and Historical Notes), Tata McGraw Hill (2009).
2. Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., An introduction to Linear Algebra, Affiliated East West Press (1976).

Reference Books

1. Kreyszig Erwin, Advanced Engineering Mathematics, John Wiley (2006), 8th edition.
2. Jain, R.K. and Iyenger, S.R.K., Advanced Engineering Mathematics, Narosa Publishing House (2011), 4th edition.

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

SEMESTER-III

<**UMA028**> : <**Mathematics for Data Science**>				
	L	T	P	Cr
	3	0	2	4.0

Course Objective: To introduce the student to the concept of Probability and Statistics that plays a vital role in computing and computational intelligence. Knowledge of these topics is critical to decision making and to the analysis of data. Using concepts of probability and statistics, individuals are able to predict the likelihood of an event occurring, organize and evaluate data.

Syllabus:

Mathematical Foundations of Data Sciences: Matrices, Vectors, Vector Spaces, Matrix Decomposition, Singular Value Decomposition, Eigenvalues and vectors, Sets and classes, Limit of a sequence of sets, rings, sigma-rings, sigma fields, monotone classes.

Probability: Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, Random variable, some common discrete and continuous distributions (Binomial, Poisson, Negative binomial, Geometric, Rectangular, Exponential, Normal, Gamma).

Bi-variate Probability Distribution: Probability distribution of functions of a random variable, Joint and marginal distributions, Conditional distributions.

Correlation and Regression: Covariance, Karl-Pearson and rank Correlation coefficients; linear regression between two variables.

Estimation: Theory of Estimation, Properties of an estimator: Unbiasedness, consistency, Method of maximum likelihood, the method of moments, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions.

Hypothesis: Introduction to Sampling Distribution (standard normal, chi-square, T& F distributions), Critical regions, Neyman-Pearson lemma (without proofs).

Parametric & Non-parametric tests: Tests for Goodness of fit: Based on Chi-square Test, one sample and paired sample tests; Sign Test, Signed-rank Test, Kolmogorov Smirnov Test.

Data Processing: Regression, Dimensionality Reduction, Linear Discriminant Analysis Principal Component Analysis.

Laboratory Work: Lab work based on the programming in MATLAB/ Python /SPSS/R language of various statistical techniques.

Course Learning Outcomes (CLO)

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

1. compute probabilities of composite events along with an understanding of random

variables and distribution functions.
2. understand the convergence of sequence in probabilities
3. analyse the correlated data and fit the linear regression models
4. make statistical inferences using principles of hypothesis tests.

Text Books

1. Meyer P. L., Introduction to Probability and Statistical Applications, Oxford & IBH, (2007).
2. Hogg, R. V. and Craig, A.T., Introduction to Mathematical Statistics, Prentice Hall of India, (2004).
3. Ross, S.M., A First Course in Probability, 9th edition, Pearson (2012).
4. Peng, D., R., R Programming for Data Science, Lulu.com (2012).

Reference Books

1. Walpole, R. E., Myers, R. H., Myers, S. L. and Ye, K.,. Probability and statistics for engineers and scientists, Pearson, (2010).
2. 2. Hestie Trevor, Tibshirani R., Friedman J., the elements of statistical learning, SpringerVerlag New York Inc., 2nd Ed., (2001).

<**UEE307**> : <**Transmission and Distribution of Electric Power**>				
	L	T	P	Cr
	2	1	0	2.5

Course Objective: To introduce the concepts of transmission lines, line insulators, cables. To get familiarize with distribution, EHV and HVDC transmission system.

Syllabus:

Introduction: Structure of power systems–Indian perspective, Interconnections and their advantages, per unit system.

Transmission Line Parameters: Choice of voltage and frequency, computation of Resistance, Inductance and capacitance for different conductors, single phase and three phase transmission lines, effect of ground on capacitance, transposition and double circuit lines, Electrostatic and Electromagnetic interference with communication lines.

Insulators: Insulator types, String efficiency, Improvement of String Efficiency though insulation grading and usage of guard ring, Insulator Failure, Arcing horns, Armoured rods and Bushing.

Transmission Line Performance: Characteristics and performance of power transmission lines: Short, Medium, Long lines, π and T models, Generalized constants, Power flow, Regulation, Power circle diagrams, Series and shunt compensation

Corona : Corona visual and disruptive, Critical voltage, Phenomenon of Corona, Corona loss, Factors affecting Corona, Ferranti Effect

Insulated Cables: Constructional features, electric field intensity, dielectric strength, Grading of cables, Cable laying procedures, Fault location Methods, High voltage cables, Thermal characteristics, Ratings of Cables, Introduction to XLPE cables.

Mechanical design of overhead transmission lines: Tension and sag calculations, Effect of ice, wind and temperature, Sag template, Stringing charts, Vibrations and vibration damper.

Distribution Systems: Power supply systems and their comparison, Classification of distribution system, Primary and secondary distribution, Ring main and radial systems, Systematic design of distribution systems.

EHV transmission and HVDC transmission: Need of EHV transmission system, types of DC links, advantages of DC transmission, EHAV and HVDC systems in India and trends. Standards: Indian Electricity Rules.

Course Learning Outcomes (CLO)

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

1. Analyse the transmission line models and evaluate its performance parameters
2. Design the transmission lines under various working conditions
3. Select the configurations of different line insulators and evaluate their performance
4. Supervise the laying of cables and fault detection in cables
5. Design the distribution system network.

Text Books

1. Chakrabarti,A.,Soni,M.L.,Gupta,P.V.andBhatnagar,U.S.,ATextBookonPowerSystem Engineering, Dhanpat Rai(2008).
2. Wadhwa, C.L., Electrical Power Systems, New Age International (P) Limited, Publishers (2008).

Reference Books

1. Gupta, B.R., Power System Analysis and Design, S. Chand(2009).
2. Nagrath, I.J. and Kothari, D.P., Power System Engineering, Tata McGraw-Hill (2007).
3. Pabla, A.S., Electric Power Distribution, McGraw-Hill (2008).
4. Stevenson, W.D., Power System Analysis, McGraw-Hill (2007).

<**UEE301**> : <**Direct Current Machines and Transformers**>				
	L	T	P	Cr
	3	1	2	4.5

Course Objective: To introduce the fundamental concepts of dc machines and transformers.

Syllabus:

General Concepts of Rotating Electrical Machines: Electromagnetic torque, Reluctance torque, Constructional features of rotating electrical machines, Classifications of rotating electrical machines, Construction of DC machines.

DC Generators: Classification of DC generator, Armature reaction, Compensating windings, Commutation, Methods of improving commutation, Characteristic of DC generators, Voltage buildup of shunt generators, Voltage regulation, Parallel operation of DC generators, Condition for maximum efficiency, Applications of DC generators.

DC Motors: Characteristic of DC motors, Speed control of DC motors, Ward−Leonard control (Voltage control), Three-point starter, four-point starter, DC shunt motor starter design, Electric breakings of DC shunt and series motors, Condition for maximum mechanical power.

Testing of DC machines: Brake test, Swinburne's test, Hopkinson's test or back to back test, Retardation test or Running test, Field's test, Applications of DC motors.

Single Phase Transformers: Introduction, Basic principle, Types of transformer, Construction, Equivalent circuit, Open circuit and short circuit, Separation of core losses, Per unit representation, Voltage regulation of a transformer, Losses in a transformer, Efficiency of a transformer, Condition for maximum efficiency, All day efficiency, Polarity test of a single−phase transformer, Sumpner's test, Parallel operation, Auto transformer.

Three-Phase Transformer: Advantages of three phase transformer, Principle of operation, Construction, Three−phase transformer connections, Open delta or V−V connection, Scott connection or T−T connection, Three−phase to two−phase conversion, Three−phase to six−phase conversion, Three−winding transformer, Parallel operation of transformers.

Special Purpose Transformers: Instrument transformers (CT and PT), Earthing transformer, Pulse transformer, High frequency transformer, Converter transformer.

Laboratory Work: DC Machines: Characteristics of generators and motors, Speed control, Efficiency, DC generators in parallel. Transformers: Open and short circuit tests, Parallel operation, Harmonics in no-load current, Three-phase connections, 3−phase to 2−phase and 6−phase conversions.

Course Learning Outcomes (CLO)

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

1. Analyse the performance characteristics of DC motors and DC generators
2. Use different methods for starting and speed control of DC motors

3. Analyse the performance of transformers under various operating conditions
4. Use and analyse special purpose transformer (s) for measurement and protection
5. Elucidate the advantages of parallel operation of generators/transformers.

Text Books

1. Bimbhra, P.S., Electrical Machinery, Khanna Publishers(2008).
2. Mukherjee, P.K. and Chakravorty, S., Electrical Machines, DhanpatRai(2004).
3. Nagrath, I.J. and Kothari, D.P., Electric Machines, Tata McGraw Hill(2004).

Reference Books

1. Bimbhra, P.S., Generalized Theory of Electrical Machines, Khanna Publishers (2007).
2. Fitzgerald, A.E., Kingsley, C. Jr. and Umans, Stephen, Electric Machinery, McGraw Hill (2002).

<**UES302**> : < **Introduction to Measurement Systems**>				
	L	T	P	Cr
	2	0	2	3.0

Course Objective: To introduce the classification of standards, to get familiar with principle, operation and comparison of electromechanical indicating instruments. To get familiarize with power and energy measurement systems, working and applications of various type of bridges and transducer.

Syllabus:

Introduction: Types of measurements, Instrument classification, Elements of an instrument, Input-output configuration of measuring instruments, Methods of correction for interfering and modifying inputs, Calibration, Static and Dynamic characteristics, measurement errors and error analysis, Classification of standards, Time and frequency standards, Electrical standards.

Electromechanical Indicating Instruments: PMMC galvanometer, Ohmmeter, Electrodynamometer, Moving iron meter, Rectifier and thermo-instruments, Comparison of various types of indicating instruments.

Power and Energy Measurement: Electrodynamometer type of wattmeter and power factor meter, Single-phase induction and Electronic energy meters. Amplitude and phase comparator, Phasor extraction and Introduction to PMU and its Applications.

Bridges for Measurement: Kelvin double bridge, AC bridges: Maxwell's bridge, Hay's bridge, Schering bridge, Wien's bridge, Low and High resistance measurement.

Electronic Instruments: Electronic multi-meter, Quantization error, Digital frequency meter, Q meter, Spectrum Analyzer, Digital Storage Oscilloscopes.

Sensors and Transducers: Basic principle and applications of Resistive, Inductive, Capacitive and, Piezoelectric sensors, Synchros and Resolvers, Fiber optic sensors, Hall-Effect, Photo transducer, Photovoltaic, Digital transducers, Tacho-generators, shaft parameters measurement in rotating shafts.

Laboratory Work: To measure sensitivity of Wheat Stone Bridge, Comparison of various types of indicating instruments, Single phase induction type energy meter, AC bridge measurement, Familiarization with storage type digital oscilloscopes.

Course Learning Outcomes (CLO)

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

1. Select various types of instruments for measurement of variables.
2. Select and use various types of sensors in different conditions.
3. Select and use various types of bridge circuits with different sensors.
4. Demonstrate the working of electronic instruments, working of sensors and transducers

Text Books

1. Golding, E.W., and Widdis, F.C., Electrical Measurements and Measuring Instruments, Pitman (2003).
2. Sawhney, A.K., A Course in Electrical and Electronic Measurements and Instrumentation, DhanpatRai and Co. (P) Ltd.(2007).
3. Nakra, B. C. and Chaudhry, K. K., Instrumentation Measurement and Analysis, Tata

McGraw–Hill (2003).

Reference Books

1. Murthy, D.V.S., Transducers and Instrumentation, Prentice–Hall of India Private Limited(2003).
2. Doeblin, E.O., Measurement systems, Applications and Design, McGraw–Hill(1982).

<**UTA030**> : <**Engineering Design Project (Buggy)**>				
	L	T	P	Cr
	1	0	4	3.0

Course Objective: The project will introduce students to the challenge of electronic systems design & integration. The project is an example of 'hardware and software co-design' and the scale of the task is such that it will require teamwork as a co-ordinated effort.

Syllabus:

Hardware overview of Arduino:

- Introduction to Arduino Board: Technical specifications, accessories and applications.
- Introduction to Eagle (PCB layout tool) software.

Sensors and selection criterion:

- Concepts of sensors, their technical specifications, selection criterion, working principle and applications such as IR sensors, ultrasonic sensors.

Active and passive components:

- Familiarization with hardware components, input and output devices, their technical specifications, selection criterion, working principle and applications such as-
  - Active and passive components: Transistor (MOSFET), diode (LED), LCD, potentiometer, capacitors, DC motor, Breadboard, general PCB etc.
  - Instruments: CRO, multimeter, Logic probe, solder iron, desolder iron
  - Serial communication: Concept of RS232 communication, Xbee
- Introduction of ATtiny microcontroller based PWM circuit programming.

Programming of Arduino:

- Introduction to Arduino: Setting up the programming environment and basic introduction to the Arduinomicro-controller
- Programming Concepts: Understanding and Using Variables, If-Else Statement, Comparison Operators and Conditions, For Loop Iteration, Arrays, Switch Case Statement and Using a Keyboard for Data Collection, While Statement, Using Buttons, Reading Analog and Digital Pins, Serial Port Communication, Introduction programming of different type of sensors and communication modules, DC Motors controlling.

Basics of C#:

- Introduction: MS.NET Framework Introduction, Visual Studio Overview and Installation
- Programming Basics: Console Programming, Variables and Expressions, Arithmetic Operators, Relational Operators, Logical Operators, Bitwise Operators, Assignment Operators, Expressions, Control Structures, Characters, Strings, String Input, serial port communication: Read and write data using serial port.
- Software code optimization, software version control.

Laboratory Work:

Schematic circuit drawing and PCB layout design on CAD tools, implementing hardware module of IR sensor, Transmitter and Receiver circuit on PCB.

Bronze Challenge: Single buggy around track twice in clockwise direction, under full supervisory control. Able to detect an obstacle. Parks safely. Able to communicate state of the track and buggy at each gantry stop to the console.

Silver Challenge: Two buggies, both one loop around, track in opposite directions under full supervisory, control. Able to detect an obstacle. Both park safely. Able to communicate state of the track and buggy at each gantry stop with console.

Gold Challenge: Same as silver but user must be able to enter the number of loops around the track beforehand to make the code generalized.

Course Learning Outcomes (CLO)

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

1. Recognize issues to be addressed in a combined hardware and software system design
2. Draw the schematic diagram of an electronic circuit and design its PCB layout using CAD Tools
3. Apply hands-on experience in electronic circuit implementation and its testing
4. Demonstrate programming skills by integrating coding, optimization and debugging for different challenges
5. Develop group working, including task sub-division and integration of individual contributions from the team.

Text Books

1. Michael McRoberts, Beginning Arduino, Technology in Action Publications, 2nd Edition.
2. Alan G. Smith, Introduction to Arduino: A piece of cake, Create Space Independent Publishing Platform (2011).

Reference Books

1. John Boxall, Arduino Workshop - a Hands-On Introduction with 65 Projects, No Starch Press; 1st edition (2013).

<UTD 003> <APTITUDE SKILLS BUILDING>				
	L	T	P	Cr
	2	0	0	2

Course Objective:

The course aims to equip students with a comprehensive understanding of quantitative, verbal, and logical reasoning concepts, enhancing their ability to solve numerical problems, interpret written information, and evaluate arguments effectively. It provides exposure to various aptitude test formats, and time-management strategies, and offers practice opportunities with personalized feedback to build confidence and prepare students for aptitude tests, increasing their job market competitiveness and career advancement opportunities.

Verbal Ability & Reading Comprehension: Introduction to Reading Comprehension: Strategies for approaching different types of passages, identifying main ideas, and understanding structure, Advanced reading techniques, dealing with inferences, tone, and author's purpose, Introduction to Verbal Ability: Grammar Fundamentals, sentence structure, common errors, Sentence Correction and Completion, Review and Test-Taking Strategies: Consolidate knowledge from all areas, focusing on test-taking strategies, time management, and practice tests.

Quantitative & Logical Reasoning: Introduction to Quantitative Ability - Arithmetic Basics: arithmetic concepts (numbers, operations, percentages, ratios, averages), Advanced Arithmetic & Introduction to Algebra: more complex arithmetic (interest, partnerships, mixtures, ratios, variation) and basics of algebra (equations, inequalities, speed, time and distance), Algebra Continued & Introduction to Modern Math: quadratic equations, sequences and introduce concepts of modern math set theory, probability, permutations, combinations, and more complex probability problems, Introduction to Data Interpretation: Basics of data interpretation, understanding and interpreting bar charts and pie charts, Data Interpretation - Line Charts and Tables, interpreting trends, and comparing data, practice session with mixed problems from quantitative ability and data interpretation, Introduction to Logical Reasoning: Number Series and Sequences, Family Relationships and Directions.

Course Learning Outcome

CLO 1: Ability to identify and provide solutions for complex problems and apply the basics of mathematics

CLO 2: Able to analyze and interpret data from various sources to identify trends and make data-driven comparisons.

CLO 3: Able to evaluate logical reasoning scenarios to identify patterns, solve sequences, and make accurate inferences.

CLO 4: Able to improve communication skills, including correcting errors, refining structure, and enhancing verbal proficiency.

CLO 5: Able to analyze various types of information to identify key points, infer meaning, and understand underlying tones and purposes.

Text Books

1. *Aggarwal, R.S., Quantitative Aptitude for Competitive Examinations; S Chand (2017)*
2. *Agarwal, A., An expert guide to problem-solving: with practical examples; CreateSpace Independent Publishing Platform (2016)*
3. *Other supplemental materials: Instructor prepared material disseminated through social media tools & apps*

4. *M. Tyra, Magical Book on Quicker Maths, Fifth Edition, BSC Publishing Co Pvt Ltd, 2018*
5. *K Kundan, Advanced Verbal Reasoning, Tyrasons Publications, 2021*
6. *Wren and Martin, English Grammar Book, S. Chand Publication, 2024*

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	EST	50
2	Sessional	40
3	Assignment	10

<**UCS321**> : < **AI FUNDAMENTALS FOR ENGINEERS**>				
	L	T	P	Cr
	2	0	2	3.0

Course Objective: Develop foundational AI knowledge while equipping participants with practical problem-solving skills using data relevant to engineering applications.

1.Introduction to AI for Engineers : Definitions: Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), Reinforcement Learning (RL) • Understanding AI's role in engineering decision-making • Illustrative examples from engineering fields (e.g., predictive maintenance, process control)

2. Data and Preprocessing : Types of data: sensor data, image data, text data, and time-series data • Techniques for cleaning, normalization, and handling missing values • Introduction to feature selection methods

3. Supervised Learning :Core algorithms: Linear Regression, Logistic Regression, Decision Trees, Random Forest • Applications: Predicting equipment failure or component lifespan

4. Unsupervised Learning : Clustering techniques: K-Means, DBSCAN • Dimensionality reduction methods: Principal Component Analysis (PCA), t-SNE • Applications: Process classification and anomaly detection

5. Neural Networks & Deep Learning (Intro) : Fundamentals of Neural Networks: Multilayer Perceptron (MLP), Convolutional Neural Networks (CNN) • Use cases: Image recognition (e.g., detecting cracks in structures)

6. Time-Series Analysis • Forecasting techniques: ARIMA and introductory Long Short-Term Memory (LSTM) models • Applications: Load prediction and vibration analysis

7. Toolchain for Engineers • Programming tools: Python, Jupyter Notebook • Libraries: pandas, scikit-learn, TensorFlow/Keras • Version control: Using Git effectively

8. Mini Project : Choose an engineering-specific dataset • Apply preprocessing, modeling, and evaluation techniques

Laboratory Work:

- Build a regression model to predict temperature rise in a motor
- Use K-Means clustering to group materials based on properties
- Create a neural network to detect faulty circuits

Case Studies

• Siemens: AI applications in industrial automation

• General Electric (GE): AI-driven turbine health monitoring

• Honeywell: Predictive maintenance in smart factories

SEMESTER-IV

<**UEE401**> : <**Alternating Current Machines**>				
	L	T	P	Cr
	3	1	2	4.5

Course Objective: To introduce the concept of single phase and three phase AC machines, their construction and performance parameters.

Syllabus:

Three–Phase Induction Motors: Construction, working principle, Sip and its effect on rotor parameters: rotor frequency, Torque–slip characteristics, Power flow diagram, Efficiency, Synchronous watt, Measurement of slip, Equivalent circuit, No–load test, Blocked rotor test, Circle diagram, Starting methods, Speed control methods, Crawling, Cogging, Deep cage and Double cage rotors, Applications, self-excited and grid connected Induction generator.

Fractional kW Motors and Special Machines: Classification, Production of rotating field, Double revolving field theory, Equivalent circuit, Determination of equivalent circuit parameters, Split phase induction motor, Capacitor motor, Permanent split capacitor motor; Shaded pole motor, Universal motor, Stepper motor.

Synchronous Generators/Alternators: Introduction, Comparison with DC generator, Advantages of rotating field over rotating armature, Constructional features, Excitation systems, Armature windings, EMF equation, Winding factor, Harmonics, Armature resistance, Armature reaction: Unity power factor, Zero lagging and Zero leading power factor, Armature reaction reactance, Equivalent circuit of an alternator, Voltage equation, Phasor diagram of a loaded alternator for various types of loads, Voltage regulation and methods of estimation of voltage regulation, Load characteristic of alternators, power equation, Two reaction theory and Torque angle characteristic of a salient pole alternator, Maximum reactive power for a salient pole alternator, Losses and efficiency, Determination of Xd and Xq, Parallel operation of alternators, Synchronising procedures, Synchronising power and Torque coefficient, Damper Windings, Hunting.

Synchronous Motors: Voltage equation, Phasor diagram, Operation at constant load with variable excitation, Power equations, salient pole Synchronous motor, Starting of synchronous motors, Applications, Synchronous condensers.

Laboratory Work: Reactances of cylindrical and salient-pole synchronous machines, Voltage regulation, Operating characteristics, Synchronizing, Parallel operation and load division, determination of sub-transient, transient and steady state reactances and various time constants, Determination of positive, negative and zero sequence reactances, Synchronous motor starting, Efficiency. Three phase induction motors: starting methods, Equivalent circuit parameters, Load test, Polarity test, Single phasing, Efficiency, Schrage motor, Single-phase induction motors: Equivalent circuit parameters.

Course Learning Outcomes (CLO)

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

1. Comprehend the operation, test and performance and speed control of three-phase

induction motor
2. Analyse the performance of fractional kW motors
3. Comprehend the performance, test and control of synchronous machines.
4. Elucidate the advantages of alternators connected in parallel.

Text Books

1. Bimbhra, P.S., Electrical Machinery, Khanna Publishers (2008).
2. Mukherjee, P.K. and Chakravorty, S., Electrical Machines, Dhanpat Rai and Co. (P) Ltd. (2004).
3. Nagrath, I.J. and Kothari, D.P., Electric Machines, Tata McGraw Hill (2004).
4. Sawhney, A. K., and Chakrabarti, A. Course in electrical machine design. Dhanpat Rai (2006).

Reference Books

1. Bimbhra, P.S., Electrical Machinery, Khanna Publishers (2008).
2. Mukherjee, P.K. and Chakravorty, S., Electrical Machines, Dhanpat Rai and Co. (P) Ltd. (2004).
3. Nagrath, I.J. and Kothari, D.P., Electric Machines, Tata McGraw Hill (2004).

<**UTA018**> : <**Object Oriented Programming**>				
	L	T	P	Cr
	3	0	2	4.0

Course Objective: To become familiar with object oriented programming concepts and be able to apply these concepts in solving diverse range of applications.

Syllabus:

Objects and Classes: Structure in C and C++, Class specification, Objects, Namespaces, Overview of pillars of OOPS (Data Encapsulation, Data Abstraction, Inheritance, Polymorphism), Inline functions, Passing objects as arguments, Returning object from a function, Array of objects, Static keyword with data member, member function and object, Friend function, and Friend classes, Pointer to objects, this pointer, Dynamic Initialization, Dynamic memory allocation.

Constructor and Destructor: Constructors and its types, Constructor Overloading, Constructors in array of objects, Constructors with default arguments, Dynamic Constructor, Destructor, 'const' keyword with data member, member function and object.

Inheritance: Introduction to Inheritance, Forms of Inheritance (Single, Multiple, Multilevel, Hierarchical and Hybrid) with various modes (Public, Private and Protected), Inheritance with Constructor and Destructor, Benefits and Limitations of Inheritance.

Polymorphism: Classification of Polymorphism (Compile-time and Run-time), Compile Time-Function Overloading, Operator Overloading (Unary operator and Binary operator with member function and friend function), Data Conversion (Basic to user-defined, user-defined to basic, one user-defined to another user-defined). Run-time- Pointers to derived class object, Overriding member function, Virtual functions, pure virtual functions, Abstract class.

Exception Handling, Templates and Standard Template Library: Exception handling mechanism, Usage of template, Function templates, Overloading of Function templates, Class templates, Introduction to Standard Template Library and its components. Algorithms, Containers (Array, Vector, Stack, List and Queue) and Iterators.

Laboratory Work: To implement object oriented constructs using C++programming language

Course Learning Outcomes (CLO)

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

1. To recall the knowledge of structure and its variables to comprehend the concept of classes, objects, constructors and destructors for implementing the object oriented paradigms.
2. To apply and analyze the inheritance on real life case studies via coding competences.
3. To design and develop code snippets for polymorphism to proclaim coding potential; and management of run-time exceptions.
4. To assess and interpret the knowledge of templates to appraise the standard template libraries.

Text Books

1. C++:The Complete Reference , Schildt H., Tata McGraw Hill, 4thed, 2003
2. C++Primer, Lippman B.S., Lajoie J., and MooE.B., , Addison-Wesley Professional, 5th ed, 2013

Reference Books

1. Object-Oriented Programming in C++, Lafore R., Pearson Education, 4thed, 2002
2. Object Oriented Programming with C++, E Balagurusamy, 8th ed,2017
3. The C++programming language, Stroustrup B., Pearson Education India, 4thed, 2013

<**UEE409**> : < **Network Theory**>				
	L	T	P	Cr
	3	1	2	4.5

Course Objective: To make the students understand the concepts of graph theory, two port networks, filter and attenuators.

Syllabus:

Graph Theory: Graph, Tree and link branches, Network matrices and their relations, Choice of linearly independent network variables, Topological equations for loop current and for nodal voltage, Duality.

Network Theorems: Source transformation, Superposition theorem, Thevenin's theorem, Norton's theorem, Millman's theorem, Reciprocity theorem and Maximum power transfer theorem as applied to ac circuits, Compensation theorem, Tellegen's theorem and their applications.

Two Port Networks: Two port network description in terms of open circuits impedance, Short circuit admittance, Hybrid and inverse hybrid, ABCD and inverse ABCD parameters, Inter- connection of two port network, Indefinites admittance matrix and its applications.

Network Functions: Concepts of complex frequency, Transform impedance, Networks function of one port and two port network, concepts of poles and zeros, property of driving point and transfer function.

Passive Network Synthesis: Introduction, Positive Real Functions: Definition, Necessary and sufficient conditions for a function to be positive real, Synthesis vs. analysis, Elements of circuit synthesis, Foster and Cauer forms of LC Networks, Synthesis of RC and RL networks.

Filters and Attenuators: Classification of Filters, Analysis of a prototype low pass, high pass, band pass, band stop and m-derived filters, Attenuation, Types of attenuators: symmetrical and asymmetrical.

Active Filters: Introduction to Active filters, first and second order low pass Butterworth filter, First and second order high pass Butterworth filter, Band pass filter.

Laboratory Work: Verification of Network Theorems, Determination of Z, Y, hybrid and ABCD parameters of two port network, Inter-connection of two port networks, Implementation of different types of filter and attenuator configurations.

Course Learning Outcomes (CLO)

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

1. Apply various laws and theorems to solve electric networks
2. Analyse the behaviour of two port networks
3. Apply graph theory concept to solve electrical networks
4. Realise one-port network parameters
5. Design different filter and attenuator configurations.

Text Books

1. Hayt, W., Engineering Circuit Analysis, Tata McGraw–Hill (2006).

2. Hussain, A., Networks and Systems, CBS Publications(2004).
3. Valkenberg, Van, Network Analysis, Prentice–Hall of India Private Limited(2007).
4. Gayakwad, A. Op-Amps and Linear Integrated Circuits, Prentice–Hall of India(2006).

Reference Books

1. Chakarbarti,A., Circuit Theory, Dhanpat Rai and Co. (P) Ltd.(2006).
2. Roy Chowdhury, D. Network and Systems, New Age International (P) Limited (2007).
3. Suresh Kumar, K.S. Electrical circuits and Networks, Pearson Education,(2009).

<**UEE412**> : <ANALOG AND DIGITAL CIRCUITS>				
	L	T	P	Cr
	3	0	2	4.0

Course Objective: To analyze working of BJT biasing circuits and MOSFET, Analysis of operational amplifier circuits, active filters and oscillators, to design sequential digital circuits and analyze converters.

Syllabus:

Biasing and Thermal Stabilization: Load line analysis, Transistor biasing, Thermal Runaway, Bias Stabilization, Structure, working, output and transfer characteristics of JFET and MOSFET.

Amplifiers: RC coupled Amplifier: Working, Analysis (Calculation of Voltage Gain, Current Gain, Input and Output Impedance), Frequency Response, Power Amplifiers: Class A, Class B, Class AB, and Class C, Calculation of Maximum Efficiency, Power Dissipation, Push-Pull configuration and elimination of Crossover Distortion.

Operational amplifiers: Introduction and characteristics of op amp, Comparators, Schmitt Trigger (Regenerative Comparator), and Peak Detectors, Half-wave and Full-wave Precision Rectifiers.

Active filters and Oscillators: Design of active filters using op amp, condition for sustained oscillation, R-C phase shift, Hartley, Colpitts, Crystal and Wien Bridge Oscillators.

Sequential logic circuits: Flip-flops, registers and designing of counters.

Converters: Analog to digital conversion (flash type, dual slope, successive approximation), digital to analog conversion (binary weighted resistor, binary ladder or R-2R ladder).

Memories: Memory Units, Memory Addressing, Introduction and classification of ROM, Static and Dynamic RAM, Flash memory, Memory Expansion.

Laboratory Work: RC coupled amplifier in CE mode, FET Characteristics, Active filters and Oscillator circuits, flip flops, binary counters, asynchronous and synchronous up/down counters, Converters

Minor Project: Automatic intensity control of street lights, auto night lamp with high power LED, water level alarm, panic alarm, dc motor control using L298N motor driver module and Arduino. Design of LED lighting system for household application, Design of digital systems.(Any topic related to course work)

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

1. Design different types of transistor biasing circuits
2. Analyze the performance of amplifier and op-amp-based circuits
3. Design active filters and oscillator circuits
4. Design sequential logic circuits .
5. Demonstrate the concept of ADC, DAC and memories.

Text Books

1. Boylestad R. L., Electronic Devices and Circuit Theory, Pearson Education(2007).

2. Millman, J. and Halkias, C.C., Integrated Electronics, Tata McGraw Hill(2006).
3. Floyd, T.L. and Jain, R. P., Digital Fundamentals, Pearson Education (2008).
4. Tocci,R. and Widmer,N., Digital Systems: Principles and Applications, Pearson Education (2007).

Reference Books

1. Neamen, Donald A., Electronic Circuit Analysis and Design, McGraw Hill(2006).
2. Sedra A. S. and Smith K. C., Microelectronic Circuits, Oxford University Press(2006).
3. Mano, M. M. and Ciletti, M., Digital Design, Pearson Education(2008).
4. Kumar, A., Fundamentals of Digital Circuits, Prentice Hall(2007).

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

<**UMA035**> : < **Optimization Techniques**>				
	L	T	P	Cr
	3	0	2	4.0

Course Objective: The main objective of the course is to formulate mathematical models and to understand solution methods for real life optimal decision problems. The emphasis will be on basic study of linear and non-linear programming problems, Integer programming problem, Transportation problem, Two person zero sum games with economic applications and project management techniques using CPM.

Syllabus:

Scope of Operations Research: Introduction to linear and non-linear programming formulation of different models.

Linear Programming: Geometry of linear programming, Graphical method, Linear programming (LP) in standard form, Solution of LP by simplex method, Exceptional cases in LP, Duality theory, Dual simplex method, Sensitivity analysis.

Integer Programming: Branch and bound technique, Gomory's Cutting plane method. Network Models: Construction of networks, Network computations, Free Floats, Critical path method (CPM), optimal scheduling (crashing). Initial basic feasible solutions of balanced and unbalanced transportation problems, optimal solutions, assignment problem.

Multiobjective Programming: Introduction to multiobjective programming, efficient solution, efficient frontier.

Nonlinear Programming: Unconstrained Optimization: unimodal functions, Fibonacci search method, Steepest Descent method, Conjugate Gradient method

Constrained Optimization: Concept of convexity and concavity, Maxima and minima of functions of n-variables, Lagrange multipliers, Karush-Kuhn-Tucker conditions for constrained optimization.

Laboratory Work: Lab experiments will be set in consonance with materials covered in the theory using Matlab.

Course Learning Outcomes (CLO)

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

1. formulate the linear and nonlinear programming problems
2. solve linear programming problems using Simplex method and its variants
3. construct and optimize various network models
4. construct and classify multiobjective linear programming problems
5. solve nonlinear programming problems.

Text Books

1. Chandra,S.,Jayadeva,Mehra,A.,NumericalOptimizationandApplications,Narosa Publishing House,(2013)
2. Taha H.A., Operations Research-An Introduction, PHI (2007).

Reference Books

1. Pant J. C., Introduction to optimization: Operations Research, Jain Brothers(2004)
2. BazaarraMokhtar S., Jarvis John J. and Shirali Hanif D., Linear Programming and Network flows, John Wiley and Sons(1990)
3. Swarup, K., Gupta, P. K., Mammohan, Operations Research, Sultan Chand & Sons, (2010).
4. H.S. Kasana and K.D. Kumar, Introductory Operations Research, Springer publication,(2004)
5. Ravindran,D.T.PhillipsandJamesJ.Solberg:OperationsResearch-Principlesand Practice, John Wiley & Sons, Second edn.(2005).

<UCS421> : < ETHICS AND RISK MITIGATION>				
	L	T	P	Cr
	3	0	0	3.0

Course Objective: Empowering engineers to navigate ethical and societal implications of AI in safety-critical domains

1. Introduction to AI Ethics

Understanding the distinction between ethics and compliance is foundational for AI engineers. While compliance ensures adherence to regulations and standards, ethics delves deeper into principles guiding the responsible use of AI. Engineers will explore the core principles of fairness, accountability, transparency, and privacy, emphasizing their relevance in decision-making processes.

2. Bias in Engineering AI Models

Bias in engineering applications can manifest in various forms, such as calibration bias in sensors or the use of biased datasets during model training. Engineers will study real-world examples to understand how biases can lead to safety system failures or discrimination in access to services. This module equips participants to recognize, mitigate, and manage biases effectively.

3. Data Privacy & Governance

With the increasing integration of AI into sensitive domains like smart grids and health sensors, data privacy and governance are crucial. Participants will examine the Indian DPDP Act and GDPR, focusing on their relevance to engineering IoT systems. The goal is to understand how to handle sensitive data responsibly while maintaining compliance with global standards.

4. Explainable AI (XAI)

Explainable AI bridges the gap between black-box models and interpretable systems. Engineers will learn about tools such as SHAP and LIME, which provide insights into AI decision-making processes. Practical applications will include explaining AI-based decisions in process control systems, ensuring transparency and trust in high-stakes engineering environments.

5. AI in Critical Systems

Critical systems such as autonomous vehicles, robotics, and power grids demand rigorous risk management. Engineers will explore risk categories specific to these applications, emphasizing redundancy and fallback mechanisms. The module highlights the necessity of robust systems capable of mitigating risks and maintaining operational safety.

6. Safety-by-Design

Safety-by-design principles entail proactive measures to ensure the reliability of AI systems. Engineers will investigate fail-safe models and strategies to combat adversarial attacks on control systems. Furthermore, the module will underscore the importance of engineering responsibility in deploying AI, ensuring that safety remains the highest priority.

7. Governance and Standards

AI governance frameworks, such as IEEE AI ethics and NIST standards, provide a structured approach to ethical deployment. Engineers will study these frameworks and learn how to create AI audit templates tailored to engineering applications. This module fosters a systematic approach to maintaining accountability and compliance.

8. AI Policy & Case Resolution

Real-world simulations will challenge participants to create AI policies for smart plant operations, addressing ethical dilemmas and practical constraints. Engineers will evaluate case studies of ethical failures to understand lessons learned and apply them to future engineering scenarios.

Laboratory Work: Hands-on exercises are integral to this course, enabling engineers to apply theoretical knowledge in practical settings:

• Bias detection using SHAP: Participants will analyze sensor data to identify and mitigate biases effectively.

• Privacy impact assessment: Engineers will use templates to evaluate privacy implications in smart home data.

• AI audit checklist creation: Developing comprehensive checklists for AI-driven drone navigation to ensure safety and compliance.

Case Studies

• The course incorporates comprehensive case studies to illustrate the real-world implications of ethics and risk mitigation in AI:

• Boeing 737 MAX: Analyzing software bias and identifying gaps in risk mitigation strategies.

• Tesla autopilot: Exploring failures in AI systems and the importance of robust data governance.

• AI in nuclear reactor control: Insights from IAEA on the role of ethical AI in maintaining safety in critical applications.

Evaluation

The assessment framework is designed to evaluate both theoretical understanding and practical application:

• Scenario-based short answers: Accounting for 30%, this segment tests engineers' ability to respond to ethical dilemmas in AI contexts.

• Ethics audit: Another 30% focuses on evaluating engineers' capacity to critically assess and audit AI systems.

• Final case report and group discussion: Constituting 40%, this segment promotes collaborative learning and comprehensive evaluation of case studies.

By the end of this course, engineers will be equipped with the knowledge and tools necessary to implement AI systems that prioritize ethics, mitigate risks, and uphold societal trust in safety-critical applications.

Approved in 3rd meeting of the Academic Council held on 18th March, 2026