COURSE SCHEME AND SYLLABUS

FOR

B.E.

(Electrical and Computer Engineering)

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

2023

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

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**
3.	UHU003	PROFESSIONAL COMMUNICATION	HSS	2	0	2	**3**
4.	UES102	MANUFACTURING PROCESSES	ESC	2	0	2	**3**
5.	UMA010	MATHEMATICS–I	BSC	3	1	0	**3.5**
		TOTAL		12	6	6	**18**

SEMESTER-II

S. NO.	COURSE CODE	COURSE NAME	CODE	L	T	P	CR
1.	UCB009	CHEMISTRY	BSC	3	0	2	**4**
2.	UES103	PROGRAMMING FOR PROBLEM SOLVING	ESC	3	0	2	**4**
3.	UES013	ELECTRICAL & ELECTRONICS ENGINEERING	ESC	3	1	2	**4.5**
4.	UEN008	ENERGY AND ENVIRONMENT	HSS	2	0	0	**2**
5.	UMA004	MATHEMATICS–II	BSC	3	1	0	**3.5**
		TOTAL		14	2	6	**18**

Credits (end of First Year/ II semester): 36

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SEMESTER-III

S. NO.	COURSE CODE	COURSE NAME	CODE	L	T	P	CR
1.	UMA301	DISCRETE MATHEMATICAL STRUCTURES	BSC	3	1	0	**3.5**
2.	ULC301	DATA STRUCTURES	PCC	3	0	2	4
3.	ULC302	INTRODUCTION TO NETWORK THEORY	PCC	3	1	0	3.5
4.	UES301	ANALOG CIRCUITS	ESC	2	0	2	3
5.	ULC303	COMPUTER ARCHITECTURE AND ORGANIZATION	PCC	3	0	0	3
6.	UTA030	ENGINEERING DESIGN PROJECT (BUGGY)	PRJ	1	0	4	3
7.	UTD003	APTITUDE SKILLS BUILDING	HSS	2	0	0	2.0
		TOTAL		17	2	8	**22.0**

Credits (end of III sem): 58

SEMESTER-IV

S. NO.	COURSE CODE	COURSE NAME	CODE	L	T	P	CR
1.	ULC403	DESIGN AND ANALYSIS OF ALGORITHMS	PCC	3	0	2	4
2.	ULC404	OPERATING SYSTEMS	PCC	3	0	2	4
3.	UMA028	MATHEMATICS FOR DATA SCIENCE	BSC	3	0	2	4
4.	UTA018	OBJECT ORIENTED PROGRAMMING	ESC	3	0	2	4
5.	UEE413	ELECTRIC MACHINERY	PCC	3	1	2	4.5
6.	ULC405	PRINCIPLES OF POWER SYSTEM ENGINEERING	PCC	3	1	0	3.5
7.	UHU050	EVOLUTIONARY PSYCHOLOGY (1 SELF EFFORT HOUR)	HSS	1*	0	0	1.0
*****Alternate Week		TOTAL		18 +1*	2	10	**25**

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Credits (end of IV sem): 83

SEMESTER-V

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1	ULC501	DATA BASE MANAGEMENT SYSTEMS	PCC	3	0	2	4
2	ULC502	COMPUTER NETWORKS	PCC	3	0	2	4
3	UEE508	LINEAR CONTROL SYSTEMS	PCC	3	1	2	4.5
4	UEE512	POWER CONVERTERS AND DRIVES	PCC	3	1	2	4.5
5	UTA025	INNOVATION AND ENTREPRENEURSHIP	OTH	1	0	2	3
6		ELECTIVE-I	PEC	3/2	0	0/2	3
		TOTAL		16/15	2	10/12	**23**

Credits (end of V sem): 106

SEMESTER-VI

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1	ULC601	MACHINE LEARNING TECHNIQUES	PCC	3	0	2	4
2	UEE511	EMBEDDED SYSTEMS DESIGN AND IOT	PCC	3	0	2	4
3	ULC602	DIGITAL MEASUREMENT AND PROTECTION	PCC	3	0	2	4
4	UMA601	MATHEMATICS FOR SIGNAL PROCESSING	BSC	2	1	2	3.5
5	UHU005	HUMANITIES FOR ENGINEERS	HSS	2	0	2	3
6		ELECTIVE -II	PEC	3/2	0	0/2	3
7	ULC691	CAPSTONE PROJECT (STARTS)	PRJ	0	0	2	0
				16/15	1	12/14	21.5

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Credits (end of VI sem): 127.5

SEMESTER-VII

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1	ULC703	THEORY OF COMPUTATION	PCC	3	1	0	3.5
2	ULC603	ELECTRIC VEHICLE AND REAL TIME SYSTEMS	PCC	3	0	2	4
3	ULC701	SMART ELECTRIC GRID AND ENERGY MANAGEMENT	PCC	3	0	0	3
4		ELECTIVE -III	PEC	3/2	0	0/2	3
5		GENERIC ELECTIVE	OEC	2	0	0	2
6	ULC691	CAPSTONE PROJECT	PRJ	0	0	2	8
		TOTAL		14/13	1	4/6	**23.5**

Credits (end of VII sem): 151

SEMESTER-VIII

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1	ULC802	SOCIAL NETWORK ANALYSIS	PCC	2	0	2	3
2	ULC803	ETHICAL HACKING	PCC	3	0	2	4
3	ULC892	DESIGN PROJECT	PRJ	--	--	--	8
OR							
1	ULC891	PROJECT SEMESTER	PRJ	--	--	--	15
OR							
1	ULC893	START-UP SEMESTER	PRJ	--	--	--	15

Total Credits (end of VIII sem): 166

BASKETS OF SPECIALIZATION

S.No	Specialization	Elective-I (Semester-V)	Elective-II (Semester-VI)	Elective-III (Semester-VII)
1	**Mathematics and Computing**	Data Mining and Visualization	Deep Learning	Forecasting Methods and Applications
2	**High End Computing**	Cloud Computing	Deep Learning	GPU computing
3	**Computer Animation and Gaming**	Computer Vision	3D Modelling and Animation	Game Design & Development
4	**Information and grid security**	Cyber and Network security	Block Chain Technology and Applications	Grid Security
5	**Electric Vehicle**	Battery Management System	EV Charging Infrastructure	Autonomous Mobility

LIST OF ELECTIVES

S.No.	Course No.	Course Name	L	T	P	Cr
Elective -I						
1	ULC511	BATTERY MANAGEMENT SYSTEM	2	0	2	3
2	ULC512	CLOUD COMPUTING	2	0	2	3
3	UCS653	DATA MINING AND VISUALIZATION	2	0	2	3
4	UMC622	MATRIX COMPUTATION	2	0	2	3
5	ULC664	CYBER AND NETWORK SECURITY	2	0	2	3
6	ULC702	INDUSTRIAL COMMUNICATION PROTOCOLS AND SCADA	3	0	0	3
7	ULC513	SOFTWARE ENGINEERING	2	0	2	3
8	UCS532	COMPUTER VISION	2	0	2	3
Elective -II						
1	UCS754	BLOCK CHAIN TECHNOLOGY AND APPLICATIONS	2	0	2	3
2	ULC665	DEEP LEARNING	2	0	2	3
3	ULC621	EV CHARGING INFRASTRUCTURE	2	0	2	3
4	ULC663	CYBER PHYSICAL SYSTEMS	3	0	0	3

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5	UEE525	DATA ANALYTICS METHODS	2	0	2	3
6	ULC742	DIGITAL CONTROL SYSTEMS	3	0	0	3
7	UCS636	3D MODELLING AND ANIMATION	2	0	2	3
8	ULC744	FACTS AND CUSTOM POWER	3	0	0	3
Elective -III						
1	ULC741	ADVANCED METERING INFRASTRUCTURE	3	0	0	3
2	ULC731	GRID SECURITY	2	0	2	3
3	ULC643	FORECASTING METHODS AND APPLICATIONS	2	0	2	3
4	ULC745	MODERN PROPULSION SYSTEM AND ROBOTICS	2	0	2	3
5	UMA038	OPTIMISATION AND HEURISTICS	2	0	2	3
6	UCS751	SIMULATION AND MODELLING	2	0	2	3
7	UCS646	GAME DESIGN & DEVELOPMENT	2	0	2	3
8	UCS635	GPU COMPUTING	2	0	2	3
9	ULC641	AUTONOMOUS MOBILITY	3	0	0	3

List of Generic Electives

S.No.	Course No.	Course Name	L	T	P	Cr
1	UHU016	INTRODUCTORY COURSE IN FRENCH	2	0	0	2.0
2	UHU017	INTRODUCTION TO COGNITIVE SCIENCE	2	0	0	2.0
3	UHU018	INTRODUCTION TO CORPORATE FINANCE	2	0	0	2.0
4	UCS002	INTRODUCTION TO CYBER SECURITY	2	0	0	2.0
5	UPH064	NANOSCIENCE AND NANOMATERIALS	2	0	0	2.0
6	UEN006	TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT	2	0	0	2.0
7	UMA069	GRAPH THEORY AND APPLICATIONS	2	0	0	2.0
8	UMA070	ADVANCED NUMERICAL METHODS	2	0	0	2.0
9	UBT510	BIOLOGY FOR ENGINEERS	2	0	0	3.0
10	UTD004	CAMPUS 2 CORPORATE	2	0	0	3.0

Table 1: Nature of course and code

Nature of the course	**CODE****
Basic Science Courses	BSC
Engineering Science Courses	ESC
Humanities and Social Science Courses	HSS
Professional Core Courses	PCC
Professional Elective Courses	PEC
Open Elective Courses	OEC
Project	PRJ
Others {not available/specified in the categories mentioned here}	*OTH*

Table 3: Total Credit Score for specific Nature of course/s

Nature of the course	CODE	Total Credits	Semester and Course Name
Basic Science Courses	BSC	*29.5*	<1, Applied Physics> <1, Mathematics–I> <II, Applied Chemistry> <II, Mathematics–II> <III, Discrete Mathematical Structures> <IV, Mathematics for Data Science> <VI, Mathematics for Signal Processing> <VII, Optimisation and Heuristics, Elective>
Engineering Science Courses	ESC	*23.5*	<I, Engineering Drawing> <I, Manufacturing Processes> <II, Programming for Problem Solving> <II, Electrical & Electronics Engineering> <III, Object Oriented Programming> <III, Analog Circuits>
Humanities and Social Science Co	HSS	*11*	<I, Professional Communication> <II, Energy and Environment> <VI, Humanities For Engineers> <Semester III, Employability Development Skills> <Semester IV, Evolutionary Psychology>
Professional Core Courses	PCC	*66*	<III, [Data Structures, Introduction to Network Theory, Computer Architecture And Organization] > <IV, [Design and Analysis of Algorithms, Operating Systems, Electric Machinery, Principles of Power System Engineering]> <V, [Data Base Management Systems**, Computer Networks, Linear Control Systems, Power Converters and Drives]> <VI,[Machine Learning Techniques, Embedded Systems Design and IoT, Digital Measurement and Protection]> <VII,[Theory of Computation, Electric Vehicle and Real Time Systems, Smart Electric Grid and Energy Management]>
Open Elective Courses	OEC	*2*	<VII, Generic Elective>
Project	PRJ	*26*	<IV, Engineering Design Project(BUGGY) > <VI-VII, Capstone Project> <VIII, Project Semester>

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UPH013: Physics

L	T	P	Cr
3	1	2	4.5

Course Objectives: 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 Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, 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

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

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UES101: Engineering Drawing

L	T	P	Cr
2	4	0	4.0

Course Objectives: 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

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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 Outcomes (CLOs) /Course Outcomes (COs):

On completion of this course, 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

Evaluation Elements	Weightage %
MST (1.5 hours-CAD based) (MST)	**20**
EST (2 hours-CAD based) (ESE)**	**45**
AutoCAD tutorials/SolidWorks/Project work*	**35**

* Students are required to bring their personal computers for the tutorial work.

* Availability of institute server resources for sharing the software licenses with the student community.

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

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UHU003: Professional Communication

L	T	P	Cr
2	0	2	3.0

Course Objectives: 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.

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Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, 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

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

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UMA010: Mathematics-I

L	T	P	Cr
3	1	0	3.5

Course Objectives: 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 Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, 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.

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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

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

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UES102: Manufacturing Processes

L	T	P	Cr
2	0	2	3.0

Course Objectives: 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.

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Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, 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

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UCB009: Chemistry

L	T	P	Cr
3	0	2	4.0

Course Objectives: 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. onducting currents through a dielectric.

Course Learning Outcomes (CLOs) /Course Outcomes (COs): On completion of this course, 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.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

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

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

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 ifelse, 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

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

Laboratory Work

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

Course Learning Outcomes (CLOs) /Course Outcomes (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 file handling 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

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UES013:ELECTRICAL AND ELECTRONICS ENGINEERING

L	T	P	Cr
3	1	2	4.5

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

Syllabus

DC Circuits: Introduction to circuit elements; rms and average values for different wave shapes, 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; steady state and transient response of R-L and R-C and R-L-C circuits.

AC 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 and parallel circuits; balanced three phase circuits: voltage, current and power relations for star and delta arrangement; analysis of balanced and unbalanced circuits; three phase power measurement using two-wattmeter and one-wattmeter methods.

Magnetic circuits: analogy between electric and magnetic circuits; series and parallel magnetic circuits; operating principles of electrical appliances: single-phase transformer and rotating machines; tests and performance of single-phase transformer.

Digital Logic Design: Digital signals, 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), Gate primitives, Logic Gates and Universal Gates, Minimization of logic functions, Karnaugh Maps, Logic implementation using Gates, Decoder, MUX, Flip-Flops, Asynchronous up/down counters.

Electronic Devices: p- n junction diode: V-I characteristics of diode, Operation of Bipolar Junction Transistor, CB and CE configuration, Transistor as a switch, Operation of SCR, DIAC and TRIAC.

Operational Amplifier Circuits: 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 (CLOs) /Course Outcomes (COs):

On 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).

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UEN008: Energy and Environment

L	T	P	Cr
2	0	0	2.0

Course Objectives: 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 Outcomes (CLOs) /Course Outcomes (COs): On completion of this course, 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).

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

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

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UMA004: Mathematics - II

L	T	P	Cr
3	1	0	3.5

Course Objectives: 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 Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, 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.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

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

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UMA301: DISCRETE MATHEMATICAL STRUCTURES

L	T	P	Cr
3	1	0	3.5

Course Objectives: The course objective is to provide students with an overview of Discrete Mathematical Structures. Students will learn about topics such as logic and proofs, sets and functions, graph theory, boolean algebra, number theory and other important discrete math concepts.

Syllabus

Sets, Relations, and Functions: Sets: Operations on set, Inclusion-exclusion principle, Representation of Discrete Structures, Fuzzy set, Multi-set, bijective function, Inverse and Composition of functions, Floor and Ceiling functions, Growth of functions: Big-O notation, Big-Omega and Big-Theta Notations, Determining complexity of a program, Hash functions.

Relations: Different types of relation and their representation, Equivalence and partialordered relations, Partition and Covering of a set, N-ary relations and database, Closure of relations, Warshall's algorithm, Lexicographic ordering, Hasse diagram, Lattices, Boolean algebra.

Graphs Theory: Representation, Type of Graphs, Paths and Circuits: Euler Graphs, Hamiltonian Paths & Circuits; Cut-sets, Connectivity and Separability, Planar Graphs, Isomorphism, Graph Coloring, Covering and Partitioning, Application of Graph theory in real-life applications.

Basic Logic: Propositional logic, Logical connectives, Truth tables, Normal forms (conjunctive and disjunctive), Validity of well-formed formula, Propositional inference rules (concepts of modus ponens and modus tollens), Predicate logic, Universal and existential quantification, Proof Techniques.

Recurrence Relation: Solving linear recurrence relations, divide and conquer algorithms and recurrence relations.

Algebraic Structures: Group, Semi group, Monoids, Ring, Field, Homomorphism.

Number Theory: Divisibility and Modular Arithmetic, Solving Congruences, Applications of Congruences, Cryptographic applications.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Perform operations on various discrete structures such as set, function, and relation.
2. Apply basic concepts of asymptotic notation in the analysis of the algorithm.
3. Illustrate the basic properties and algorithms of graphs and apply them in modelling and solving real-world problems.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

4. Comprehend formal logical arguments and translate statements from a natural language into their symbolic structures in logic.
5. Identify and prove various properties of rings, fields, and groups.
6. Illustrate and apply the division algorithm, mod function, and Congruence.

Text Books:

1. Discrete Mathematics and its Applications, Rosen H. K., McGraw Hill, 7th ed., 2011
2. Discrete Mathematical Structures with Applications to Computer Science, Tremblay P. J. and Manohar, R., Tata McGraw Hill, 2008.

Reference Books:

1. Contemporary Abstract Algebra, Gallian A. J., Cengage Learning, 9th ed., 2017
2. Discrete Mathematics, Lipschutz S., Lipson M., McGraw-Hill, 3rd ed., 2007

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC301: DATA STRUCTURES

L	T	P	Cr
3	0	2	4.0

Course Objectives: To become familiar with different types of data structures and their applications.

Syllabus

Analyzing algorithms: Basics of algorithm and its analysis, Complexity classes, order arithmetic, Time and space trade-off in algorithms.

Linear Data Structures: Arrays, Strings and string processing, Linked lists (Singly, Doubly, Circular), Abstract data types, their implementation and applications: Stacks (using Arrays and Linked-list), Queues (using Arrays and Linked-list), Hash tables: Hash functions, collision resolution techniques, Strategies for choosing the appropriate data structure.

Searching and Sorting: Linear Search, Binary Search. Introduction to internal and external sort, Bubble Sort, Selection Sort, Insertion Sort, Shell Sort, Quick Sort, Merge Sort, Counting Sort, Radix Sort.

Trees and their applications: Introduction to binary tree, tree traversal algorithms, Binary search tree, AVL Tree, B Tree etc. and common operations on these trees. Heap, Heap Sort, Priority Queue using Heap.

Graphs and their applications: Graph Terminology and its representation, Depth and breadth first traversals, Shortest-path algorithms (Dijkstra and Floyd), Data Structures for Disjoint Sets, Minimum spanning tree (Prim and Kruskal).

Laboratory Work

Implementation of various data structures such as Arrays, Stacks, Queues, Lists, Binary tree traversals, BST, AVL trees, Graphs traversals, Sorting and Searching techniques.

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

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

1. Understand the fundamental data structures, their implementation and some of their standard applications.
2. Select and implement appropriate searching and sorting techniques for solving a problem based on their characteristics.
3. Apply tree and graph data structures for specific applications.
4. Design and analyse algorithms using appropriate data structures for real-world problems.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

Text Books:

1. Introduction to Algorithms, Cormen H. T., Leiserson E. C., Rivest L. R., and Stein C, MIT Press,3rd ed., 2009
2. Data Structures, Algorithms and Applications in C++, Sahni S., Universities Press 2nd ed. 2005

Reference Books:

1. Data Structures and Algorithms Made Easy, Karumanchi N., Career Monk Publications, 5th ed., 2017
2. Data structures and algorithms in C++, Adam Drozdek, 4th edition

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC302 : INTRODUCTION TO NETWORK THEORY

L	T	P	Cr
3	1	0	3.5

Course Objectives: To make the students understand the concepts of graph theory, two port networks, filter design, attenuators, oscillator and network synthesis.

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: Superposition Theorem, Thevenin's theorem, Norton's theorem, and Maximum power transfer theorem as applied to A.C. circuits, 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 Mderived filter, 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.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this 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. Realize one-port network parameters
5. Design different filter and attenuator configurations.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

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 Chowdhuary, D., Networks and Systems, New Age International (P) Limited, Publishers (2007).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UES301: ANALOG CIRCUITS

L	T	P	Cr
2	0	2	3.0

Course Objectives: To analyse working of BJT and MOSFET, understand multi-stage and power amplifications, working of operational amplifiers, active filters and oscillators.

Syllabus

Biasing and Thermal Stabilization: Transistor biasing and load line analysis, structure, working and applications of MOSFET, output and transfer characteristics, Thermal Runaway, Thermal Stability, biasing schemes.

Amplifiers: low and high frequency analysis of single stage amplifiers, h-parameter models, variation of parameters, short-circuit current gain, gain-bandwidth product frequency compensation, current mirrors, multistage amplifiers.

Differential and operational amplifiers: Basic operations, negative and positive feedback, distortion and frequency response of an amplifier, applications of amplifiers for multi-stage and power amplifications, CMOS Operational Amplifier: Structure, Analysis and Design, Frequency Response and Compensation Techniques. Switched Capacitor Circuits: Principles of operation, Filter and non-filter applications.

Active filters and Oscillators: Design of Butterworth filters using op amp, condition for sustained oscillation, R-C phase shift, Hartley, Colpitts, Crystal and Wien Bridge Oscillators, Negative Resistance oscillator; Multi-vibrators (Astable, Mono-stable, Bi-Stable).

Laboratory Work

RC coupled amplifier in CE mode, application of bistable, astable and monostable multivibrators, Hartley and Colpitts oscillator.

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.

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

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

1. Design different types of transistor biasing circuits
2. Analyse the applications of amplifiers for multi-stage and power amplifications
3. Design Butterworth active filters and oscillator circuits

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).

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

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).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

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ULC303:COMPUTER ARCHITECTURE AND ORGANIZATION

L	T	P	Cr
3	0	0	3.0

Course Objectives: Focus is on the architecture and organization of the basic computer modules viz. controls unit, central processing unit, input-output organization and memory unit.

Syllabus

Basics of Computer Architecture: Number System and Code Conversion, Logic Gates, Flip Flops, Registers, Counters, Multiplexer, De-multiplexer, Decoder, Encoder etc.

Register Transfer and Micro Operations: Register Transfer Language, Register Transfer, Bus & Memory Transfer, Arithmetic Micro Operations, Logic Micro Operations, Shift Micro Operations, Design of ALU.

Basic Computer Organization: Instruction Codes, Computer Instructions, Design of Timing & Control Unit, Instruction Cycles, Computer Instructions: Memory, Register, and Input-Output Reference Instructions, Interrupts, Complete Computer Description & Design of Basic Computer.

Central Processing Unit: General Register Organization, Stack Organization, Instruction Format, Addressing Modes, Data Transfer & Manipulation, Program Control, RISC, CISC.

Computer Arithmetic: Representation of Numeric Data, Signed and Unsigned Arithmetic, Addition & Subtraction, Multiplication Algorithms: Shift and Add, Booth Multiplier.Floating Point Representation.

Memory Unit: Memory Hierarchy, Processor vs. Memory Speed, High-Speed Memories, Main Memory, Cache Memory and Mapping Schemes, Associative Memory, Interleaving, Virtual Memory, Memory Management Techniques.

Introduction to Parallel Processing: Pipelining, Instruction Pipeline, Arithmetic Pipeline, Performance Metrics and Hazards. Introduction to Advance Processors (Multiprocessors and Multi-cores), Interprocessor Arbitration.

Input Output Organization: Peripheral Devices, I/O Interface Data Transfer Schemes, Program Control, Synchronous and Asynchronous Data Transfer, Priority Interrupt, DMA Transfer, I/O Processor.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Illustrate various elementary concepts of computer architecture including, syntax of register transfer language, micro operations, instruction cycle, and control unit.
2. Describe the design of basic computer with instruction formats & addressing modes.

3. Explore various memory management techniques and algorithms for performing addition, subtraction and division etc.
4. Interpret the concepts of pipelining and advance processors

Text Books:

1. Computer System Architecture, M. Morris Mano, Prentice Hall, 3rd ed., 1991.
2. Computer Architecture and Organization, John P. Hayes, McGraw Hill, 3rd ed., 1998.
3. Computer Organization and Architecture, William Stallings, Pearson, 9th ed., 2013.

Reference Books:

1. Computer Architecture: A Quantitative Approach, John L. Hennessy and David A. Patterson, Elsevier Science,5thed., 2011.
2. System Architecture: software and hardware concepts, William E. Leigh and Dia L. Ali, South Wester Publishing Co., 2nd ed., 2000.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

UTA030: ENGINEERING DESIGN PROJECT (Buggy)

L	T	P	Cr
1	0	4	3.0

Course Objectives: 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,

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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 (CLOs) /Course Outcomes (COs):

On 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, 2 nd 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; 1 st edition (2013).

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC403: DESIGN AND ANALYSIS OF ALGORITHMS

L	T	P	Cr
3	0	2	4.0

Course Objectives: To provide students with the knowledge and skills necessary to design and analyze algorithms for solving computational problems.

Syllabus

Introduction and Complexity Analysis: Analysing algorithms, Complexity classes, Time and space trade-offs in algorithms, Recurrence relations, Analysis of iterative and recursive algorithms, Amortized Analysis.

Algorithm Design Techniques and Analysis

Divide and Conquer: Fundamentals of divide and conquer strategy, Applications such as The maximum subarray problem, Strassen's algorithm for matrix multiplication, merge sort, quick sort etc.

Greedy Algorithms: Elements of greedy strategy, Applications such as activity selection, Huffman Coding, job sequencing, fractional knapsack problem, etc.

Dynamic Programming: Elements of dynamic programming, Memorization and tabulation approaches, Applications such as matrix multiplication, 0/1 knapsack, Longest common subsequence, Optimal binary search tree, etc.

Backtracking: Introduction, Applications such as N queen problem, sum of subsets, graph coloring, etc.

Branch and Bound Algorithm: General method, Applications such as0/1 knapsack problem, Traveling salesperson problem etc.

Graphs & Algorithms: Introduction to graphs, Paths and Circuits, Euler Graphs, Hamiltonian graphs, Cut-sets, Connectivity and Separability, Covering and Partitioning, Strongly connected component, Topological sort, Max flow: Ford Fulkerson algorithm, max flow- min cut.

String Matching Algorithms: Suffix arrays, Rabin-Karp, Knuth-MorrisPratt (KMP), Boyer Moore algorithm.

Problem Classes: P, NP, NP-Hard and NP-complete, deterministic and non-deterministic polynomial time algorithm approximation, Randomized algorithms.

Laboratory Work

Implementation of various algorithmic techniques for solving common computational/engineering problems.

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Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Analyse the complexity of algorithms and implement it in a specific scenario.
2. Apply common algorithmic techniques such as greedy, dynamic programming etc. to standard computational problems
3. Design solutions by using appropriate data structures or applying algorithms such as string matching, randomized, approximation and graph.
4. Develop efficient algorithms for various computational challenging problems solving in computing

Text Books:

1. Cormen H. T., Leiserson E. C., Rivest L. R., and Stein C., Introduction to Algorithms, MIT Press (2009) 3rd ed.
2. Horwitz E., Sahni S., Rajasekaran S., Fundamentals of Computers Algorithms, Universities Press (2008) 2nd ed.

Reference Books:

1. Levitin A., Introduction to the design and analysis of algorithms, Pearson Education (2008) 2nd ed.
2. Aho A.V., Hopcraft J. E., Dulman J. D., The Design and Analysis of Computer Algorithms, Addsion Wesley (1974) 1st ed.
3. Sedgewick R. and Wayne K., Algorithms, Addison-Wesley Professional (2011), 4th ed.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC404: OPERATING SYSTEMS

L	T	P	Cr
3	0	2	4.0

Course Objectives: To understand the role, responsibilities, and algorithms involved for achieving various functionalities of an Operating System.

Syllabus

Introduction and Operating System Structures: Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, Computing Environments, Operating-System Services, User and Operating-System Interface, System Calls, Types of System Calls, System Programs, Operating-System Structure, System boot.

Process Management: Process Concept, Process Scheduling, Operations on Processes, Inter-process Communication, Overview of Threads, Multi-core Programming, Multithreading Models, CPU Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling.

Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.

Memory Management: Basic Hardware, Address Binding, Logical and Physical Address, Dynamic linking and loading, Shared Libraries, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table, Virtual Memory Management: Demand Paging, Page Replacement, Allocation of Frames, Thrashing.

Storage Management: Overview of Mass Storage Structure, Disk Structure, Disk Attachment, Disk Scheduling, RAID Structure; File Concept, Access Methods, Directory and Disk Structure, File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods.

Protection and Security: Principles of Protection, Domain of Protection, Access Matrix, Implementation of the Access Matrix, The Security Problem, Program Threats.

Process Synchronization: The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Mutex Locks, Semaphores, Classic Problems of Synchronization, Overview of Monitors.

Laboratory Work Learn and practice basic Linux/Unix commands to Create and manipulate files and directories; Explore about Vi Editor environment; Build .C program related to fork (), exec (), wait (), sleep () functions at Linux/Unix platform; Write .C program for message passing and shared memory; Simulate CPU scheduling algorithms using either C or C++

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

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1. Describe the basics of an operating system, including the kernel, system calls, and computing environments.
2. Evaluate the effectiveness and trade-offs of different models of multithreading, scheduling algorithms, and methods for handling deadlocks, such as prevention, avoidance, detection, and recovery.
3. Understand components of a memory system, virtual memory and analyze different memory management techniques.
4. Evaluate the effectiveness of different Disk Management strategies, and Critique the design and implementation of File System
5. Explain the basic concepts of Concurrency, Protection and Security issues in an operating system.

Text Books:

1. Operating System Concepts, Silberschatz A., Galvin B. P. and Gagne G., John Wiley & Sons Inc., 9th ed, 2013.
2. Operating Systems Internals and Design Principles, Stallings W., Prentice Hall 9th ed, 2018

Reference Books:

1. Understanding the Linux Kernel, Bovet P. D., Cesati M., O'Reilly Media, 3rd ed, 2006.
2. Introduction to Operating System Design and Implementation: The OSP 2 Approach, Kifer M., Smolka A. S., Springer, 2007

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UMA028: MATHEMATICS FOR DATA SCIENCE

L	T	P	Cr
3	0	2	4.0

Course Objectives: 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, Geometric, Rectangular, Exponential, Normal, Gamma etc.).

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: Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions.

Hypothesis tests: Introduction to Sampling Distribution (standard normal, chi-square, T& F distributions), Theory of Estimation, Properties of an estimator, Tests for Goodness of fit: Method of maximum likelihood, Neyman-Pearson lemma (without proofs); Critical regions.
Parametric & Non-parametric tests: 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

Based on the programming in MATLAB/ Python /R language of various statistical techniques. R for Data Science: Data Wrangling, Data Visualization, Programming, Python for Data Science: Normal Python, NumPy, Pandas, Matplotlib.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On 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.

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2. Explain the convergence of sequence in probabilities.
3. Analyze the correlated data and fit the linear regression models.
4. Interpret the 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. Hestie Trevor, Tibshirani R., Friedman J., the elements of statistical learning, Springer- Verlag New York Inc., 2nd Ed., 2001.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UTA018: OBJECT ORIENTED PROGRAMMING

L	T	P	Cr
3	0	2	4.0

Course Objectives: 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, userdefined 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 (CLOs) /Course Outcomes (COs):

On 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.

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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, 8thed, 2017
3. The C++programming language, Stroustrup B., Pearson Education India, 4thed, 2013

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UEE413 : ELECTRICAL MACHINERY

L	T	P	Cr
3	1	2	4.5

Course Objectives: The course aims to introduce the concept of D.C. Machines, Transformers, Synchronous and Asynchronous AC machines, their construction and performance parameters.

Syllabus

Direct Current Machines: Basic concept and classification of dc machines as per type of excitation, circuit models and related equations of separately and self-excited dc generators and motors, armature reaction, characteristics of dc generators, characteristics of dc motors , speed control of dc motor, DC Motor starters, losses and efficiency in DC machines .

Transformers: Working principle of three phase transformers, construction, basic phasor groups and connections of three phase transformer, V-V and Scott-Connection, Electrical tests and performance metrics, parallel operation of transformers.

Induction (Asynchronous) Motor: Principle of operation and construction, calculation of slip, rotor frequency, rotor emf, current and power, losses and efficiency, induction motor phasor diagram and equivalent circuit, torque-slip and power-slip characteristics, determination of equivalent circuit parameters from no-load test and blocked-rotor test, starting methods of induction motor, methods of speed control.

Synchronous Machines: Operating principle and construction, phasor diagrams of cylindrical and salient pole synchronous generators/alternator, Open circuit and short circuit test of synchronous machine, voltage regulation of an alternator, active and reactive power equations of synchronous machine-power-angle characteristics, synchronizing power and synchronizing torque, Parallel Operation and Synchronisation of generator with infinite bus, operating principle and application of synchronous motor.

Single-phase motors: Basic concept of single-phase induction motor, starting methods, comparison between single and poly-phase induction motors, basic working principle and application of universal motor, single-phase reluctance motor, sub-synchronous motor, hysteresis motor.

Laboratory Work

Open short and short circuit tests on transformer, parallel operation of transformer, measurements of harmonics in inrush current, Scott connection and load sharing, no load, and external characteristics of self and separately excited DC generators, Speed control of DC shunt motor, open circuit and blocked rotor test on induction motor, speed control of induction motor, motor starting methods, voltage regulation of synchronous generator, V and inverted V curves of Synchronous generator, active and reactive power control of synchronous generator.

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

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

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1. Analyse the performance of three phase transformers.
2. Analyse the load sharing with parallel connected single phase/three phase transformers.
3. Analyse the performance characteristics of DC motors and DC generators
4. Use different methods for starting and speed control of DC motors.
5. Analyse tests, characteristics and steady state performance of Three-phase induction motor.
6. Comprehend the performance and test of synchronous machines.
7. Analyse performance of single machine – infinite bus system and number of alternators connected in parallel.

Text Books:

1. D.P. Kothari and I.J. Nagrath, Electric Machines, 4e, Tata McGraw Hill Education Private Limited, New Delhi.
2. P.S. Bimbhra, Electrical Machinery, 7ed., Khanna Publishers, New Delhi.
3. P.S. Bimbhra, Generalized Theory of Electrical Machines, 5e, Khanna Publishers, New Delhi.

Reference Books:

1. Toro, Vincert, Electromechanical Devices for Energy Conversion, Prentice Hall of India.
2. Fitzgerald, A.E., Kingsley, C. Jr., and Umans, Stephen, Electric Machinery, 6e, McGraw Hill, USA.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC405 : PRINCIPLES OF POWER SYSTEM ENGINEERING

L	T	P	Cr
3	1	0	3.5

Course Objectives: The course aims to impart a critical theoretical and practical introduction to electrical, mechanical design of transmission system and steady state analysis of network.

Syllabus

Introduction to Power System: Structure of power systems, Growth of power systems-Indian overview, Interconnections and their advantages. Power Supply Systems and their comparison, High voltage Transmission Systems.

Electrical Design of Transmission Line: Choice of voltage and frequency, Types of conductor, Size of conductor, Resistance, Inductance and capacitance of single phase and three phase transmission lines. Effect of ground on Capacitance. Parameters of Insulated Cables, Grading of Cables.

Mechanical Design of Transmission line: Tension and sag calculations, Factors affecting Sag, Sag template, Stringing charts, Vibrations and vibration damper.

Insulators: Insulator types, String efficiency and its Improvement.

Performance of Transmission Lines: Characteristics and performance of power transmission lines: Short, Medium, Long lines, Generalized constants, Power flow, regulation, Power circle diagrams, Series and shunt compensation, Corona, Ferranti Effect, Electrostatic and Electromagnetic interference with communication lines.

Transmission network Calculations: Single line diagram of power system, Per Unit System and its advantages, Admittance model, Modelling of regulating transformer, Bus admittance matrix assemble, Bus impedance matrix assembly.

Load Flow Studies: Load flow problem, Power flow equations, Load flow solution using Gauss Seidal and Newton Raphson methods, Decoupling between real and reactive power control, Decoupled and fast decoupled methods, Comparison of load flow methods.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Design the electrical parameters of transmission lines and insulated cables under various working conditions.
2. Describe the mechanical design (sag and tension) of transmission line under various environment and geographical conditions .
3. Develop and analyse the transmission line models and evaluate its performance.

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4. Develop an appropriate mathematical model of power system
5. Carry out load flow analysis of practical power system for balanced system.

Text Books:

1. Nagrath, I.J. and Kothari, D.P., Power System Engineering, Tata McGraw Hill (2007).
2. Stevenson, W.D., Power System Analysis, McGraw Hill (2007).
3. Gupta, B.R., Power System Analysis and Design, S. Chand and Company Limited (2009)

Reference Books:

1. M. Pai, Copmuter Techniques in Power System analysis, Tata McGraw Hill, 2nd ed., (2005).
2. Chakraborti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., A Text Book on Power System Engineering, Dhanpat Rai and Co. (P) Ltd. (2008).
3. Elgard, O.L. , Electric Energy Systems Theory, McGraw Hill Publications , 2nd ed., (2017).

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

ULC501: DATABASE MANAGEMENT SYSTEMS

L	T	P	Cr
3	0	2	4.0

Course Objectives: Emphasis is on the need of database systems. Main focus is on E-R diagrams, relational database, concepts of normalization and de-normalization and SQL commands.

Syllabus

Introduction: Data, data processing requirement, desirable characteristics of an ideal data processing system, traditional file based system, its drawback, concept of data dependency, Definition of database, database management system, 3-schema architecture, database terminology, benefits of DBMS.

Relational Database: Relational data model: Introduction to relational database theory: definition of relation, keys, relational model integrity rules.

Database Analysis: Conceptual data modeling using E-R data model -entities, attributes, relationships, generalization, specialization, specifying constraints, Conversion of ER Models to Tables, Practical problems based on E-R data model.

Database Design: Functional Dependency, Canonical Covers, Candidate Key Identification, Normalization- 1NF, 2NF, 3NF, BCNF, 4NF and 5NF. Concept of De-normalization and practical problems based on these forms.

Transaction Management and Concurrency control: Concept of Transaction, States of Transaction and its properties, Need of Concurrency control, concept of Lock, Two phase locking protocol.

Recovery Management: Need of Recovery Management, Concept of Stable Storage, Log Based Recovery Mechanism, Checkpoint.

Database Implementation: Introduction to SQL, DDL aspect of SQL, DML aspect of SQL – update, insert, delete & various form of SELECT- simple, using special operators, aggregate functions, group by clause, sub query, joins, co-related sub query, union clause, exist operator. PL/SQL - cursor, stored function, stored procedure, triggers, error handling, and package.

Laboratory Work

Students will perform SQL commands to demonstrate the usage of DDL and DML, joining of tables, grouping of data and will implement PL/SQL constructs. They will also implement one project.

Project:

It will contain database designing & implementation, should be given to group of 2-4 students. While doing projects emphasis should be more on back-end programming like use of SQL, concept of stored procedure, function, triggers, cursors, package etc. Project should have continuous evaluation and should be spread over different components.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Analyze the Information Systems as socio-technical systems, its need and advantages as compared to traditional file-based systems.
2. Analyze and design database using E-R data model by identifying entities, attributes and relationships.
3. Apply and create Relational Database Design process with Normalization and Denormalization of data.
4. Comprehend the concepts of transaction management, concurrence control and recovery management.
5. Apply SQL and PL/SQL to implement database applications.

Text Books:

1. Silverschatz A., Korth F. H. and Sudarshan S., Database System Concepts, Tata McGraw Hill (2010) 6th ed.
2. Elmasri R. and Navathe B. S., Fundamentals of Database Systems, Pearson (2016) 7th ed.

Reference Books:

1. Bayross I., SQL, PL/SQL the Programming Language of Oracle, BPB Publications (2009) 4th ed.
2. Hoffer J., Venkataraman, R. and Topi, H., Modern Database Management, Pearson (2016) 12th ed.
3. Parteek Bhatia and Gurvinder Singh, Simplified Approach to DBMS (2016)
4. Raghu Ramakrishnan and Johannes Gehrke, Database management systems, Tata McGraw Hill (2002), 3rd Edition.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC502: COMPUTER NETWORKS

L	T	P	Cr
3	0	2	4.0

Course Objectives: The subject will introduce the basics of computer networks to students through a study of layered models of computer networks and applications.

Syllabus

Introduction: Organization of the Internet, ISP, Network criteria, Categories of networks, Network performance and Transmission Impairments. Network Devices, OSI Model, TCP/IP Protocol Suite, Layering principles, Line Encoding, Switching technique and Multiplexing.

Local Area Networks: LAN topologies: Bus topology, Ring topology, Token passing rings, FDDI, Star topologies, Asynchronous transfer mode, Ethernet, IEEE standards 802.3, 802.5. Wireless LANs: IEEE 802.11 and Bluetooth, introduction to Virtual circuit switching including frame relay, X.25, and ATM.

Reliable Data Delivery: Error control (retransmission techniques, timers), Flow control (Acknowledgments, sliding window), Multiple Access, Performance issues (pipelining).

Routing and Forwarding: Routing versus forwarding, Static and dynamic routing, Unicast and Multicast Routing. Distance-Vector, Link-State, Shortest path computation, Dijkstra's algorithm, Network Layer Protocols (IP, ICMP), IP addressing, IPV6, Address binding with ARP, Scalability issues (hierarchical addressing).

Process-to-Process Delivery: UDP, TCP and SCTP, Multiplexing with TCP and UDP, Principles of congestion control, Approaches to Congestion control, Quality of service, Flow characteristics, Techniques to improve QoS.

Network Applications: Naming and address schemes (DNS, IP addresses, Uniform Resource Identifiers, etc.), Distributed applications (client/server, peer-to-peer, cloud, etc.), HTTP as an application layer protocol, Electronic mail, File transfer, Remote login.

Laboratory Work To design conceptual networks using E-Draw, Visual Studio etc. and to implement topologies BUS, RING, STAR, Mesh and configuring Router using Packet tracer or GNS3 platform.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Conceptualize and explain the functionality of the different layers within a network architecture
2. Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies, sub-netting and routing mechanism.
3. Demonstrate the operation of various routing protocols and their performance analysis.

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4. Illustrate design and implementation of datalink, transport and network layer protocols within a simulated/real networking environment.
5. Comprehend various protocols and be able to analyse design issues in application layer.

Text Books:

1. Forouzan A. B., Data communication and Networking, McGraw Hill (2012) 5th ed.
2. Tanenbaum S. A. and Wetherall J. D., Computer Networks, Prentice Hall (2013) 5th ed.

Reference Books:

1. Kurose J. and Ross K., Computer Networking: A Top Down Approach, Perason (2017) 7th ed.
2. Stallings W., Computer Networking with Internet Protocols and Technology, Pearson (2004).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UEE508: LINEAR CONTROL SYSTEMS

L	T	P	Cr
3	1	2	4.5

Course Objectives: Course Objectives: To understand concepts of the mathematical modeling, feedback control, stability and analysis in time and frequency domains

Syllabus

Basic Concepts: Open and closed loop control systems, mathematical modelling of electrical, mechanical, thermal, hydraulic and pneumatic systems, concept of transfer function, block diagrams and signal flow graphs.

Control hardware and their models: Potentiometers, Synchros, LVDT, DC and AC servomechanisms,Techo-generators, and Stepper motors.

Analysis: Steady-state errors and error constants, transient accuracy, disturbance rejection, insensitivity and robustness.

Basic Models of Feedback Control: Concepts of P, PD, PI and PID types of control and their realizations.

Stability: Definition, Routh-Hurwitz criterion, Root locus techniques, Polar plots, Bode plots, Nyquist criterion, Relative stability, concepts of gain and phase margins.

Compensation: Lead, Lag and lag-lead compensators, Design of compensating networks for specified control system performance.

State Space Analysis: Concepts of state, State variables and state models, State space equations, transfer function, Transfer model, State space representation of dynamic systems, State transition matrix, Decomposition of transfer function, Controllability and observability.

Introduction to Digital Control.

Laboratory Work Linear system simulator, Compensation design, D.C. position control and speed control, Synchro characteristics, Servo demonstration, Stepper motor, Potentiometer error detector, Rate control system, Series control system, Temperature control system, simulation examples of control problems with MATLAB/Simulink software.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Develop the mathematical model of the physical systems.
2. Analyse the response/stability of the closed and open loop systems.

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3. Design the various kinds of compensators.
4. Develop and analyse state space models

Text Books:

1. Nagrath, I.J. and Gopal, M., Control System Engineering, New Age International (P) Limited, Publishers (2021).
2. Ogata, K., Modern Control Engineering, Prentice Hall of India Private Limited (2001).
3. Bishop & Dorf, Modern Control System, Addison Weseley, 13th Ed. (Pearson), (2022)

Reference Books:

1. Kuo, B.C., Automatic Control System, Prentice Hall of India Private Limited (2002).
2. Sinha, N.K., Control System, New Age International (P) Limited, Publishers (2002).
3. Allen J. Wood, Bruce F. Wollenberg and Gerald B. Sheble, Power Generation, Operation and Control, Wiley-Interscience (2013).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UEE512: POWER CONVERTERS AND DRIVES

L	T	P	Cr
3	1	2	4.5

Course Objectives: The course aims at familiarizing the student with the principles and control of power electronics converters and their application in electric drives

Syllabus

Power Electronics Device as a Switch: Introduction to power electronics technology and its comparison with linear electronics; Ideal switches and their classification based on V-I characteristics; Static and dynamic Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT, Gate/Base drive circuits (power circuits, working principle, waveforms and design): Non-isolated Buck, Boost and Buck-Boost converters. Cuk, SEPIC, Isolated DC-DC converters: flyback, forward, half & full bridge.

AC to DC Conversion: Phase Controlled Converters: Principle of phase control, Single phase and three phase converter circuits with different types of loads, continuous and discontinuous conduction, effect of source inductance. Harmonic analysis

DC to AC Conversion: Single phase voltage source bridge inverters and their steady state analysis; three-phase bridge inverters with 180° and 120° modes; single-phase and three- phase PWM inverters.

AC to AC Conversion: AC Voltage Controllers: Types , single-phase voltage controller with R and RL type of loads. Harmonic analysis Cyclo-converters: Principles of operation, single-phase to single-phase step-up and step- down cyclo-converters.

Drives Application of Power Electronics: Concept of electric drive and its classifications, Types of loads, Four-quadrant drive, Dynamics of motor-load combination, Steady state stability of an electric drive system, Load Equalization

Control of AC and DC motors: Staring and Speed Control of AC and DC motors fed through single-phase and three-phase controlled power converter configurations. Regeneration and braking of AC and DC motors through static power converters.

Laboratory Work SCR V-I characteristics, Gate firing circuit, DC -DC chopper, Semi converter and Full converter with R , RL and RLC type of loads, Single phase AC voltage controller with R load, three-phase PWM inverter, Simulation of power electronics converters using (Simulink/PLECS/ PSIM). Starting and running characteristics of converter fed AC and DC motor control, Harmonic analysis of AC and DC Drives, V/f based drive.
Minor Project: Drive simulation using multi-dimensional software such as ANSYS Maxwell/ PExprt.

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Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Select the power devices as per the usage for energy conversion and control.
2. Analyse various DC-DC converter configuration / topology with different types of load.
3. Analyse phase controlled converter configurations.
4. Identify DC-AC converter configurations for various power applications.
5. Conceptualize the basic drive system and analyse it for different types of loads.

Text Books:

1. Rashid, M., Power Electronics, Prentice Hall of India (2006).
2. Bimbhra, P.S., Power Electronics, Khanna Publishers(2012).
3. Mohan, N., Underland, T. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley (2007) 3rded.
4. Vithayathil, J, Power Electronics: Principles and Applications, Tata McGraw Hill, Indian Edition.
5. Bose, B.K., Modern Power Electronics and AC Drives, Prentice-Hall of India Private Limited (2006).
6. Dubey, G.K., Fundamentals of Electric Drives, Narosa Publications (2001)

Reference Books:

1. Rashid, M.H., A Handbook of Power Electronics, Elsevier.
2. Krein, P.T., Elements of Power Electronics, Oxford University Press (2012).
3. Leonhard, W., Control of Electric Drives, Springer (2001).
4. Wang,L., Chai, S., Yoo, D., Gan, L., Ng, K., PID and Predictive Control of Electrical Drives and Power Converters using MATLAB / Simulink, IEEE-Wiley Press (2014)

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UTA025: INNOVATION AND ENTREPRENEURSHIP

L	T	P	Cr
1	0	2*	3.0

Course Objectives: This course aims to provide the students with a basic understanding in the field of entrepreneurship, entrepreneurial perspectives, concepts and frameworks useful for analyzing entrepreneurial opportunities, understanding eco-system stakeholders and comprehending entrepreneurial decision making. It also intends to build competence with respect business model canvas and build understanding with respect to the domain of start- up venture finance.

Syllabus

Introduction to Entrepreneurship: Entrepreneurs; entrepreneurial personality and intentions - characteristics, traits and behavioural; entrepreneurial challenges.

Entrepreneurial Opportunities: Opportunities- discovery/ creation, Pattern identification and recognition for venture creation: prototype and exemplar model, reverse engineering.

Entrepreneurial Process and Decision Making: Entrepreneurial ecosystem, Ideation, development and exploitation of opportunities; Negotiation, decision making process and approaches, - Effectuation and Causation.

Crafting business models and Lean Start-ups: Introduction to business models; Creating value propositions - conventional industry logic, value innovation logic; customer focused innovation; building and analyzing business models; Business model canvas, Introduction to lean start-ups, Business Pitching.

Organizing Business and Entrepreneurial Finance: Forms of business organizations; organizational structures; Evolution of organization, sources and selection of venture finance options and its managerial implications. Policy Initiatives and focus; role of institutions in promoting entrepreneurship.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Explain the fundamentals behind the entrepreneurial personality and their intentions
2. Discover/create and evaluate opportunities.
3. Identify various stakeholders for the idea and develop value proposition for the same.
4. Describe various Business Models and design a business model canvas.
5. Analyse and select suitable finance and revenue models for start-up venture.

Text Books:

1. Ries, Eric, The lean Start-up: How constant innovation creates radically successful businesses, Penguin Books Limited. (2011)

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

2. Blank, Steve , The Startup Owner's Manual: The Step by Step Guide for Building a Great Company, K&S Ranch. (2013)

3. S. Carter and D. Jones-Evans, Enterprise and small business- Principal Practice and Policy, Pearson Education (2006)

Reference Books:

1. T. H. Byers, R. C. Dorf, A. Nelson, Technology Ventures: From Idea to Enterprise, McGraw Hill (2013)

2. Osterwalder, Alex and Pigneur, Yves , Business Model Generation. (2010)

3. Kachru, Upendra, India Land of a Billion Entrepreneurs, Pearson

4. Bagchi, Subroto, (2008), Go Kiss the World: Life Lessons For the Young Professional, Portfolio Penguin

5. Bagchi, Subroto, (2012). MBA At 16: A Teenager's Guide to Business, Penguin Books

6. Bansal, Rashmi, Stay Hungry Stay Foolish, CIIE, IIM Ahmedabad

7. Bansal, Rashmi, (2013). Follow Every Rainbow, Westland.

8. Mitra, Sramana (2008), Entrepreneur Journeys (Volume 1), Booksurge Publishing

9. Abrams, R. (2006). Six-week Start-up, Prentice-Hall of India.

10. Verstraete, T. and Laffitte, E.J. (2011). A Business Model of Entrepreneurship, Edward Elgar Publishing.

11. Johnson, Steven (2011). Where Good Ideas comes from, Penguin Books Limited.

12. Gabor, Michael E. (2013), Awakening the Entrepreneur Within, Primento.

13. Guillebeau, Chris (2012), The $100 startup: Fire your Boss, Do what you love and work better to live more, Pan Macmillan

14. Kelley, Tom (2011),The ten faces of innovation, Currency Doubleday

15. Prasad, Rohit (2013), Start-up sutra: what the angels won't tell you about business and life, Hachette India.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC601: MACHINE LEARNING TECHNIQUES

L	T	P	Cr
3	0	2	4.0

Course Objectives: To understand the need, latest trends and design appropriate machine learning algorithms for problem solving.

Syllabus

Introduction: Definitions of learning systems, machine learning, supervised vs. unsupervised vs. reinforcement learning, training and test data, concept representation, function approximation for learning system; Objective functions and evaluation metrices (MSE, MAE, R^2, AUC-ROC) for classification, and regression.

Concept of Optimization: Convex function, gradients and sub-gradients, ADAM, RMSProp optimizers, gradient descent, Constrained optimization, Stochastic gradient descent, Mini batch training, Hyperparameter tuning: Grid search.

Data Pre-processing: Methods for Data cleaning, Data integration, Data transformation, Data Reduction; Feature Scaling (Normalization and Standardization), Splitting dataset into Training and Testing set, Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA), t-SNE, UMAP, Correlation based feature selection.

Regression and Supervised learning Linear regression and LMS algorithm, Perceptron and logistic regression, Nonlinear function estimation, Overfitting, Regularization (L1/L2), Cross-validation.

Decision Tree Learning for classification and regression: Representing concepts as decision trees, Recursive induction, splitting attributes, simple trees and computational complexity, Overfitting, noisy data, and pruning.

Support Vector Machines for classification: Maximum margin linear separators, solution approach to finding maximum margin separators, Radial basis function network, kernels and Mercer's theorem, Kernels for learning non-linear functions, support vector regression.

Bayesian Learning: Probability and Bayes rule, Naive Bayes learning algorithm, Parameter smoothing, Generative vs. discriminative training, Bayes nets and Markov nets for representing dependencies.

Clustering: Learning from unclassified data, Clustering and its types, k-means partitioned clustering, Fuzzy C-means, Expectation maximization (EM) for soft clustering, Gaussian Mixture Model.

Applications to Power System: Some of the Power System applications but not restricted to energy pricing estimation, energy meter analytics, renewable generation forecasting, load profile and consumer classification, Controller design for ALFC, Filter design, Economic load dispatch.

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Laboratory Work The laboratory work includes supervised learning algorithms, linear regression, logistic regression, decision trees, k-nearest neighbour, Bayesian learning and the naïve Bayes algorithm, support vector machines and kernels and neural networks with an introduction to Deep Learning and basic clustering algorithms.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Apply supervised and unsupervised learning algorithms to solve classification, regression, and clustering tasks
2. Exhibit the knowledge of dimensionality reduction and other pre-processing steps on raw datasets.
3. Apply regularization methods to reduce overfitting in machine learning models.
4. Select and apply appropriate evaluation metrics to assess model accuracy and robustness.
5. Evaluate and compare learning models on real-world problems.

Text Books:

1. Mitchell T.M., Machine Learning, McGraw Hill (1997).
2. Alpaydin E., Introduction to Machine Learning, MIT Press (2010).

Reference Books:

1. Bishop C., Pattern Recognition and Machine Learning, Springer-Verlag (2006).
2. Michie D., Spiegelhalter D. J., Taylor C. C., Machine Learning, Neural and Statistical Classification. Overseas Press (2009).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UEE511: EMBEDDED SYSTEM DESIGN and IoT

L	T	P	Cr
3	0	2	4.0

Course Objectives: To understand the hardware and software concepts of embedded systems. To understand the development of embedded systems for Day-to-day applications and to handle IoT systems.

Syllabus

Introduction to Embedded system: Single purpose hardware and software, Characteristics of embedded system applications. Architectural Issues: CISC, RISC, RISC-V, DSP Architectures. Component Interfacing: interrupt, DMA, I/O Bus Structure, I/O devices. Software for Embedded Systems: Program Design and Optimization techniques, Operating system for Embedded Systems, Real-time Issues. Designing Embedded Systems .Design Issues, Hardware-Software Co-design, Use of UML.

ARM embedded application development: ARM Architecture, ARM programmer's model, Hardware and Software Requirements, Embedded Control Application Development Case study: Open Loop and Closed Loop Control and Coding of PID Controller for different applications.

Embedded application with programmable digital signal processors: Commercial digital signal processing devices, data addressing modes, memory space, program control, on chip peripherals, interrupts and pipeline operations of TMS320C54XX DSPs. Networked Embedded Systems: Distributed Embedded Architectures, Protocol Design issues, wireless network.

Internet of Things (IoT) and enabling Technologies: Introduction to Internet of Things (IoT), vision and challenges for realizing the Internet of Things, IoT architecture, design. IoT and Interoperability: Communication Protocol, Physical/Link Layer, IEEE 802.3 (Ethernet), Network Layer, Transport Layer, Application Layer, Interoperability in IoT, Interoperable communication standards: IEC 61850, Green Wireless Networking Standards (IEEE 802.15.4).

IoT Sensors modules and Actuators: Introduction to IoT based measurements, Smart sensors, MEMS etc.,Green IoT Application Development, Resource Optimization in IoT, Case Study: Solid state relay, Sensor and Motor application.

RISC-V for Edge Computing and AI in IoT, Security Aspects in RISC-V for IoT.

Laboratory Work

Programming examples of ARM based processors, Programming and Application development around ARM, Interfacing with peripherals, actuators, sensors, etc., IoT application programs.

Minor Project: Development of IoT based application such as: Home and Building Automation, Smart Grid, Smart City, Smart Farming, Smart Healthcare. Temperature Monitoring over the Internet, Smart Lighting, Voice-Controlled Door Access, RFID Reader, Cloud Example with IBM Watson Bluemix.

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

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

1. Elucidate the architecture of ARM processors and write embedded program.

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2. Interface peripherals and develop applications based on PIC/ARM processors.
3. Elucidate the IoT communication, protocols and platform properties.
4. Practice IoT applications for electrical **and electronics** systems.

Text Books:

1. Steve Furber, ARM System-on-Chip Architecture", Second Edition, Pearson Education, (2013).
2. Hanes, David, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, and Jerome Henry. IoT fundamentals: Networking technologies, protocols, and use cases for the internet of things. First ed., Cisco Press, (2017).
3. Xiao, Perry, Designing Embedded Systems and the Internet of Things (IoT) with the ARMmbed., John Wiley & Sons, (2018).

Reference Books:

1. Stephen Welsh, Peter Knaggs, ARM: Assembly Language Programming, Bourne Mouth University Publication, (2003).
2. Andrew N. Sloss, Dominic Symes, Chris Wright "ARM System Developers Guide, Designing and Optimizing System Software", Elsevier Publication. (2004)
3. Internet of Things, Abhishek S Nagarajan, RMD Sundaram Shriram K Vasudevan, Wiley India (2019).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC602: DIGITAL MEASUREMENT AND PROTECTION

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of this course is to provide a comprehensive up-to-date presentation of the fundamentals of digital measurement and digital protection through state-of-art theories and methods in digital relaying,

Syllabus

Fundamentals of Digital Measurement : Concept of sampling and aliasing, mean and RMS value theorem, power evaluation theorem, Time-division multiplexing, Quantization, A/D converters, digital instruments and their performance characteristics.

Digital Time and Frequency Measurement: Measurement of a Time Interval. Small Time Interval, Periodic Time; Phase Measurement. Measurement of R-L-C parameters.
Measurement of Frequency, ratio and multiplication of frequencies, high and low frequencies, average frequency difference. power system frequency deviation; Time reciprocating circuit; fast low-frequency measurement of sinusoidal signals, peak frequency measurement.

Estimation of phasors: Fourier transform, discrete Fourier transform, Discrete Cosine Transform; Estimation of phasors using Walsh function and Least Error Square techniques; estimation of frequency in digital relays.

Digital Relays: Fundamentals of digital relays; Basic layout and elements of the digital relays; Sliding window concept of digital relays. Digital Directional/Non-directional Overcurrent and Earth fault relays; relay coordination in an interconnected power system network: Digital distance relays.

Digital Protection of Power System equipment: Digital Differential Protection of Generator and Transformers and Busbar, Protection of transmission lines with digital distance relays; Power swing detection and blocking technique.

Frequency relaying: Load shedding, rate of frequency decline and frequency relays; Hazards and risk of islanding; Loss of coordination among protective devices: Advanced Metering: Introduction to Smart meters, Advanced metering infrastructure and phasor measurement unit (PMU)

Laboratory Work Time-current characteristics of different types of electromagnetic and digital over-current, differential relay, directional and distance relays, generator, transformer and transmission line protections, realisation of concept of grading of relays, relay co- ordination, and islanding, realisation of digital protection schemes using simulation software like MATLAB/DigSILENT.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Exhibit the knowledge of various digital measurement modules, associated circuits and sampled measurements.

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2. Apply strategies for power system protection.
3. Realize the various dynamic characteristics of digital relays for protection of transmission lines, transformers.
4. Identify the new developments in protective relaying and applications

Text Books:

1. Anderson, P.M., Power System Protection, IEEE Press, New York, 1999.
2. John A.T., Salman S.K., Digital protection for Power Systems, IEE Power Series: 15, 1995
3. Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, Protection and Switchgear, Oxford University Press, 2nd ed., New Delhi, India, 2018.

Reference Books:

1. Blackburn, J.L., Applied Protective Relaying, Westinghouse Electric Corporation, New York, 1982.
2. Oza, B. A., Nair N. C., Mehta R.P., et al., Power System Protection & Switchgear, Tata McGraw Hill, New Delhi, 2010.
3. Bhavesh Bhalja and Vijay H. Makwana, Transmission Line Protection Using Digital Technology,Springer Science, Business Media Singapore Pvt. Ltd; Singapore, January 2016
4. Phadke, A.G. and Thorp J.S., Computer Relaying for Power Systems, Research Study Press Ltd, John Wiley & Sons, Taunton, UK, 1988.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UMA601: MATHEMATICS FOR SIGNAL PROCESSING

L	T	P	Cr
2	1	2	3.5

Course Objectives: To explain the concepts of Fourier analysis, digital signal processing, stability analysis of digital system, digital filter design and application of DSP for specific protection and drive.

Syllabus

Introduction: Signals and Systems, Classification of signals, Continuous time signals and its classifications, Standard continuous time signals, Classification of continuous time systems, Discrete time signals and its classifications, Nyquist rate, Sampling theorem, Aliasing, Convolution, Correlation, Linear time invariant (LTI) system concepts.

Z-Transform: Region of Convergence (ROC), Properties of z-transform, Initial and Final Value theorems, Partial sum, Parseval's Theorem, z-transform of standard sequences, Inverse z-transform, Pole-Zero plot, System function of LTI system, Causality and Stability in terms of z-transform.

DFT and FFT: Introduction to Fourier Transform and its properties, Concept of Energy and Power spectral density, Discrete Fourier Series, Discrete Fourier Transform and its Properties, Efficient Computation of DFT using FFT algorithms, Linear Filtering Approach to Computation of DFT.

Digital Filter Structure: Describing Equation, Structures for FIR Systems, Structures for IIR Systems, Representation of Structures using Signal Flow Graph.

Design of Digital Filters: Introduction, Difference between analog and digital filters, Types of filters, LTI systems as filters, Design of IIR filters from analog filters, FIR filters design, Least square filter design, Designing digital filter from pole-zero placement, Butterworth filter design using Bilinear transformation, FIR filter design using windows, Design of filters using pole-zero combination, Analysis of coefficient quantization effects in FIR filters, Analysis of round-off errors, Dynamic range scaling, Low sensitivity digital filters, Limit cycles in IIR filters.

Laboratory Work

Convolution and correlation, Solution of difference equations using zTransform and Fourier tools, FFT and spectrum analysis, design of high pass, low pass, band pass and band stop FIR filter using window method, design of IIR filter using Matched Z Transform (MZT), Bilinear Z Transform (BZT), Pole Zero Placement and Impulse Invariant methods.

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

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

1. Exhibit the fundamental concepts of signals and systems, including their properties and classifications.
2. Apply transformation techniques like Fourier and Z-transforms to analyze signals and systems.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

3. Implement efficient structures for Digital IIR and FIR filters in signal processing applications.
4. Design and analyze digital filters to meet specific signal processing requirements.

Text Books:

1. Proakis, J.G. and Manolakis, D.G., Digital Signal Processing, Prentice Hall of India (1996).
2. Rabiner, C.R. and Gold, B., Theory and Applications of Digital Signal Processing, Prentice Hallof India (2000)

Reference Books:

1. Antonion, A., Digital Filters: Analysis Design and Application, Prentice-Hall of India (1999).
2. Oppenhein, A.V. and Schafer, R.W., Digital Signal Processing, Prentice-Hall of India (1998).
3. Helmut, U. and Willibald, W., Protection Techniques in Electrical Engg. Systems, Marcel Dekker Inc. (2001)

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

UHU005: HUMANITIES FOR ENGINEERS

L	T	P	Cr
2	0	2	3.0

Course Objectives: The objective of this course is to introduce values and ethical principles, that will serve as a guide to behavior on a personal level and in professional life. The course is designed to help the students to theorize about how leaders and managers should behave to motivate and manage employees; to help conceptualize conflict management strategies that managers can use to resolve organizational conflict effectively. It also provides background of demand and elasticity of demand to help in devising pricing strategy; to make strategic decisions using game theory and to apply techniques of project evaluation.

Syllabus

Unit 1: Human Values and Ethics

Values: Introduction to Values, Allport-Vernon-Lindzey Study of Values, Rokeach Value Survey, Instrumental and Terminal Values.

Moral and Ethical Values: Types of Morality, Kant's Principles of Morality, Factors for taking ethical decisions, Kohlberg's Theory of Moral Development.

Professional Ethics: Profession: Attributes and Ethos, Whistle-blowing.

Unit 2: Organizational Behavior

Introduction to the Field of Organizational Behaviour: Individual Behaviour, Personality, and Values, Perceiving Ourselves and Others in Organizations, Workplace Emotions, Attitudes, and Stress, Foundations of Employee Motivation and Leadership, Performance Appraisal, Conflict and Negotiation in the Workplace.

Unit 3: Economics

Demand, Supply & Elasticity – Introduction to Economics, Demand & its Determinants, Elasticity and its types

Production & Cost Analysis – Short run & Long Run Production Functions, Short run &
Long run cost functions, Economies & Diseconomies of Scale

Competitive Analysis & Profit Maximization – Perfect competition, Monopoly, Monopolistic & Oligopoly Markets

Strategy & Game Theory – Pure Strategy & Mixed Strategy Games, Dominance, Nash Equilibrium, & Prisoner's Dilemma

Capital Budgeting – Capital Projects, Net Present Value (NPV) & IRR techniques.

Laboratory Work

Practical application of these concepts by means of Discussions, Role-plays and Presentations, Analysis of Case Studies on ethics in business and whistle-blowing, leadership, managerial decision-making, Survey Analysis, and Capital Budgeting assignment.

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

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

1. Comprehend ethical principles and values and apply them as a guide to behavior in personal and professional life.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

2. Apply tools and techniques to manage and motivate employees.
3. Analyse and apply conflict management strategies that managers can use to resolve organizational conflict effectively.
4. Devise pricing strategy for decision-making.
5. Apply techniques for project evaluation.

Text Books:

1. N. Tripathi, Human Values, New Age International (P) Ltd. (2009).
2. Robbins, S. P/ Judge, T. A/ Sanghi, S Organizational Behavior Pearson, New Delhi, (2009).
3. Petersen, H.C., Lewis, W.C. and Jain, S.K., Managerial Economics, Pearson (2006).

Reference Books:

1. McKenna E. F. Business psychology and organisational behaviour. Psychology Press, New York (2006).
2. Furnham A. The Psychology of Behaviour at Work: The Individual in the organization. Psychology Press, UK (2003).
3. Salvatore, D and Srivastava, R., Managerial Economics, Oxford University Press (2010).
4. Pindyck, R and Rubinfiled, D., Microeconomics, Pearson (2017).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC691: CAPSTONE PROJECT (STARTS)

L	T	P	Cr
0	0	2	8.0

Course Objectives: To facilitate the students learn and apply an engineering design process in electrical and computer engineering, including project resource management. As a part of a team, the students will make a project, that emphasizes, hands-on experience, and integrates analytical and design skills. The idea is to provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem.

Course Description:

Capstone Project is increasingly interdisciplinary, and requires students to function on multidisciplinary teams. It is the process of devising a system, component or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs. It typically includes both analysis and synthesis performed in an iterative cycle. Thus, students should experience some iterative design in the curriculum. As part of their design experience, students have an opportunity to define a problem, determine the problem scope and to list design objectives. The project must also demonstrate that students have adequate exposure to design, as defined, in engineering contexts. Engineering standards and realistic constraints are critical in engineering design. The program must clearly demonstrate where standards and constraints are taught and how they are integrated into the design component of the project. Each group will have 4- 5students. Each group should select their team leader and maintain daily diary. Each Group will work under mentorship of a Faculty supervisor. Each group must meet the assigned supervisor (2hrs slot/week) till the end of the semester (record of attendance will be maintained), as per the time slot which will be provided to them by the respective supervisor. This is mandatory requirement for the fulfilment of the attendance as well as the successful completion of the project. The faculty supervisor of the project will continuously assess the progress of the works of the assigned groups. Some part of the analysis and design of the system will be done in the first section of project in semester VI. The second section would comprise of completion of the project in semester VII in which each team will have to submit a detailed report of the project along with a poster.

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

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

1. dentify design goals and analyse possible approaches to meet given specifications with realistic engineering constraints.
2. Design an electrical engineering project implementing an integrated design approach applying knowledge accrued in various professional courses.
3. Perform simulations and incorporate appropriate adaptations using iterative synthesis.
4. Use modern engineering hardware and software tools.
5. Work amicably as a member of an engineering design team.
6. Improve technical documentation and presentation skills.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC703: THEORY OF COMPUTATION

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course introduces basic theory of computer science and formal methods of computation. The course exposes students to the computability theory, as well as to the complexity theory.

Syllabus

Regular Languages: Alphabets, Language, Regular Expression, Definitions of Finite State Machine, Transition Graphs, Deterministic & Non-deterministic Finite State Machines, Regular Grammar, Thompson's Construction to Convert Regular Expression to NDFA & Subset Algorithm to convert NDFA to DFA, Various recent development in the Conversion of Regular Expression to NFA, Minimization of DFA, Finite State Machine with outputMoore machine and Melay Machine, Conversion of Moore machine to Melay Machine & Vice-Versa.

Properties of Regular languages: Conversion of DFA to Regular Expression, Pumping Lemma, Properties and Limitations of Finite state machine, Decision properties of Regular Languages, Application of Finite Automata.

Context Free Grammar and Push Down Automata: Context Free Grammar, Derivation tree and Ambiguity, Application of Context free Grammars, Chomsky and Greibach Normal form, Properties of context free grammar, CKY Algorithm, Decidable properties of Context free Grammar, Pumping Lemma for Context free grammar, Push down Stack Machine, Design of Deterministic and Non-deterministic Push-down stack.

Turing Machine: Turing machine definition and design of Turing Machine, Variations of Turing Machines, combining Turing machine, Universal Turing Machine, Post Machine, Chomsky Hierarchy, Post correspondence problem, Halting problem, Turing decidability.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Comprehend regular languages and finite automata and develop ability to provide the equivalence between regular expressions, NFAs, and DFAs.
2. Disambiguate context-free grammars and understand the concepts of context-free languages and pushdown automata.
3. Analyse and design efficient Turing Machines.
4. Distinguish different computing languages and classify their respective types.

Text Books:

1. Hopcroft E. J., Ullman D. J. and Motwani R., Introduction to Automata Theory, Languages and Computation, Pearson Education (2008) 3rd ed.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

2. Martin C. J., Introduction to Languages and the Theory of Computation, McGraw-Hill Higher Education (2011) 4th ed.

3. Lewis R. H., Papadimitriou H. C., Elements of the Theory of Computation, Prentice Hall (1998) 2nd ed.

Reference Books:

1. Cohen A. I. D., Introduction to Computer Theory, Wiley (1997) 2nd ed.

2. Sipser M., Introduction to the Theory of Computation, Cengage Learning (2013) 3rd ed.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC603: ELECTRIC VEHICLE AND REAL TIME SYSTEMS

L	T	P	Cr
3	0	2	4.0

Course Objectives:

The course introduces the electric vehicle (EV) technology, its benefits and challenges. To make students familiar with EV sub-systems and application of real-time simulation tools as an aid to realize EV sub-systems.

Syllabus

Introduction to Electric Vehicle – History, Components of Electric Vehicle, Comparison with Internal combustion Engine: Technology, e-mobility as sustainable solution, EV classification, Motor Torque Calculations - rolling resistance, e grade resistance, acceleration force, total Tractive Effort, Torque required on the Drive Wheel.

Electric Drive and controller-Types of Motors, Selection and sizing of Motor, RPM and Torque calculation of motor, Motor Controllers, Component sizing, Physical locations, Mechanical connection of motor, Electrical connection of motor.

Energy Storage Solutions (ESS) - Cell Types (Lead Acid/Li/NiMH), Battery charging and discharging calculation, Cell selection and sizing, Battery lay-outing design, Battery pack configuration, Battery pack construction, Battery selection criteria.

Battery Management System (BMS)/Energy Management System (EMS) - Need of BMS, active and passive cell balancing, state of charge and state of health estimation, Battery thermal management system.

Introduction to Real Time Systems - Hardware-in-loop simulation systems, distributed control architecture, reliability enhancement by redundancy, Real time operating systems: Features, primary components, Structured design of real time systems.

Control architecture in Real Time simulation: Developing a mathematical model for Power system and control, Mathematical model of the real environment, Design of hardware device meant to be used in HIL, Design of desired control schemes for AC and DC electrical machine drives and other applications.

Laboratory Work Working and Control of BLDC Motor for Two Wheeler Electrical Vehicle, PMSM Motor for 2-Wheeler Electrical Vehicle, Design and analyse a Passive Battery Management System for small Li-ion Battery Study of Battery Packaging using Cylindrical/Prismatic Cells. Testing of Charger of Electric vehicles for EV Battery, Design and analysis of speed control controller fro EV. Analysis the Symmetrical Components of Power System Network Using OPAL-RT. Design and analyse a three Level PWM Generation in OPAL-RT.

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

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

1. Comprehend the importance of electric vehicle technology in promoting sustainable development.
2. Elucidate the working of Motor(s) and Controller(s) used in EV.
3. To design battery-pack for an electric vehicle drivetrain.
4. Exhibit the knowledge of hardware-in-loop systems.
5. Mathematically model electric system and its control in real environments.

Text Books:

1. James Larminie, Electric Vehicle Technology, Wiley, A John Wiley & Sons, Ltd., Publication (2012)
2. Tom Denton, Electric and Hybrid Vehicles, 2nd Edition, (2016)
3. HIL System catalogues; Opal-RT, RTDS and Typhoon (2017)

Reference Books:

1. Ehsani, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Third Edition, CRC Press, (2018).
2. N. Hatziargyriou, Microgrids: Architectures and Control, Wiley-IEEE Press, January (2014).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC701: SMART ELECTRIC GRID AND ENERGY MANAGEMENT

L	T	P	Cr
3	0	0	3.0

Course Objectives: To get acquainted with the concepts of smart grid components., energy management system, distribution management system, techniques of communication, computer networking and cyber security for smart metering systems

Syllabus

Introduction to Smart Grid: Basics of power systems, definition of smart grid, need for smart grid in sustainable development, functions of smart grid, opportunities & barriers of smart grid, difference between conventional & smart grid, regulatory challenges, present development & International policies in smart grid.

Architecture of Smart Grid: Functional elements of Smart grid designs, transmission automation, distribution automation, renewable integration. Distribution energy sources, microgrids, storage technologies, electric vehicles and plug-in hybrids, environmental impact and economic issues. , **Advanced Metering:** Introduction to Smart meters, Advanced metering infrastructure and phasor measurement unit (PMU), SCADA system.

Tools and Techniques for Smart Grid: IP-based Protocols – Basics of Web Service and Cloud Computing, Cyber Security for Smart Grid. Objective functions, optimization techniques, the role of Conventional and evolutionary algorithms in smart grid.

Communication Technologies in Smart Grid: Introduction to communication technology, architectures, standards, PLC, Zigbee, GSM, BPL, Smart grid architecture, standards-policies, network architectures, IP-based systems, power line communications, Local Area Network (LAN) – House Area Network (HAN) – Wide Area Network (WAN) – Broadband over Power line (BPL).

Energy Management in Smart Grid: General principles, Planning and program, concept and scope of demand side management (DSM). DSM Strategy, Planning, Implementation and its application, Energy Management System (EMS) for sustainability , smart substations , substation automation, feeder Automation, smart switchgear, remote terminal unit, Intelligent electronic devices , wide area monitoring, protection and control, innovative integration of energy resources.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Analyze the concept and need for smart grid in current scenario.
2. Exhibit the Understanding of the advanced metering systems and different layers of smart grid architecture.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

3. Comprehend the role of communication systems and communication challenges in smart grids.
4. Analyze the components and functions of the energy management system to make grid more sustainable.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai, Integration of Green and Renewable Energy in Electric Power Systems, Wiley, (2009)
2. Clark W. Gellings, The Smart Grid: Enabling Energy Efficiency and Demand Response, CRC Press, (2009)
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianz hong Wu, Akihiko Yokoyama, Smart Grid: Technology and Applications, Wiley, (2012)
4. G. Masters, Renewable and Efficient Electric Power System, Wiley–IEEE Press, 2nd Edition, (2013).
5. Stuart Borlase, Smart Grids (Power Engineering), CRC Press, (2012)

Reference Books:

1. Andres Carvallo, John Cooper, The Advanced Smart Grid: Edge Power Driving Sustainability, Artech House Publishers , (2011).
2. James Northcote, Green, Robert G. Wilson Control and Automation of Electric Power Distribution Systems (Power Engineering), CRC Press.(2017)
3. James Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley, (2012)

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC691: CAPSTONE PROJECT

L	T	P	Cr
0	0	2	8.0

Course Objectives: To facilitate the students learn and apply an engineering design process in electrical and computer engineering, including project resource management. As a part of a team, the students will make a project, that emphasizes, hands-on experience, and integrates analytical and design skills. The idea is to provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem.

Course Description:

Capstone Project is increasingly interdisciplinary, and requires students to function on multidisciplinary teams. It is the process of devising a system, component or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs. It typically includes both analysis and synthesis performed in an iterative cycle. Thus, students should experience some iterative design in the curriculum. As part of their design experience, students have an opportunity to define a problem, determine the problem scope and to list design objectives. The project must also demonstrate that students have adequate exposure to design, as defined, in engineering contexts. Engineering standards and realistic constraints are critical in engineering design. The program must clearly demonstrate where standards and constraints are taught and how they are integrated into the design component of the project. Each group will have 4- 5students. Each group should select their team leader and maintain daily diary. Each Group will work under mentorship of a Faculty supervisor. Each group must meet the assigned supervisor (2hrs slot/week) till the end of the semester (record of attendance will be maintained), as per the time slot which will be provided to them by the respective supervisor. This is mandatory requirement for the fulfilment of the attendance as well as the successful completion of the project. The faculty supervisor of the project will continuously assess the progress of the works of the assigned groups. Some part of the analysis and design of the system will be done in the first section of project in semester VI. The second section would comprise of completion of the project in semester VII in which each team will have to submit a detailed report of the project along with a poster.

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

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

1. dentify design goals and analyse possible approaches to meet given specifications with realistic engineering constraints.
2. Design an electrical engineering project implementing an integrated design approach applying knowledge accrued in various professional courses.
3. Perform simulations and incorporate appropriate adaptations using iterative synthesis.
4. Use modern engineering hardware and software tools.
5. Work amicably as a member of an engineering design team.
6. Improve technical documentation and presentation skills.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC802: SOCIAL NETWORK ANALYSIS

L	T	P	Cr
2	0	2	3.0

Course Objectives: To enable students to put Social Network Analysis projects into action in a planned, informed and efficient manner.

Syllabus

Preliminaries: Graphs, Types of graphs, Representation, Bipartite graphs, Planar networks, The graph Laplacian, Random Walks, Maximum Flow and Minimum Cut Problem, Introduction to Approximation Algorithms, Definitions. Approximation algorithms for vertex cover and TSP.

Introduction to Social Networks: Types of Networks: General Random Networks, Small World Networks, Scale-Free Networks; Examples of Information Networks; Static Unweighted and weighted Graphs, Dynamic Unweighted and weighted Graphs, Network Centrality Measures; Strong and Weak ties.

Walks: Random walk-based proximity measures, Other graph-based proximity measures. Clustering with random-walk based measures, Algorithms for Hitting and Commute, Algorithms for Computing Personalized Pagerank and Sim- rank.

Community Detection: Basic concepts, Algorithms for Community Detection: Quality Functions, The Kernighan-Lin algorithm, Agglomerative/Divisive algorithms, Spectral Algorithms, Multi-level Graph partitioning, Markov Clustering; Community Discovery in Directed Networks , Community Discovery in Dynamic Networks, Community Discovery in Heterogeneous Networks, Evolution of Community.

Link Prediction: Feature based Link Prediction, Bayesian Probabilistic Models, Probabilistic Relational Models, Linear

Algebraic Methods: Network Evolution based Probabilistic Model, Hierarchical Probabilistic Model, Relational Bayesian Network, Relational Markov Network.
Event Detection: Classification of Text Streams, Event Detection and Tracking: Bag of Words, Temporal, location, ontology based algorithms. Evolution Analysis in Text Streams, Sentiment analysis.

Social Influence Analysis: Influence measures, Social Similarity - Measuring Influence, Influencing actions and interactions. Homophily, Influence maximization.

Laboratory Work Implementation of various concepts taught in the course using Python/R Programming

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Formalize different types of entities and relationships as nodes and edges and represent this information as relational data.

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2. Plan and execute network analytical computations.
3. Use advanced network analysis software to generate visualizations and perform empirical investigations of network data.
4. Interpret and synthesize the meaning of the results with respect to a question, goal, or task.
5. Collect network data in different ways and from different sources while adhering to legal standards and ethics standards.

Text Books:

1. Charu C. Aggarwal, Social Network Data Analytics, Springer; 2011.
2. S.Wasserman, K.Faust: Social Network Analysis: Methods and Applications, Cambridge Univ Press, 1994
3. Scott, J. (2007). Social network analysis: A handbook (2nd Ed.). Newbury Park, CA: Sage.
4. Knoke (2008). Social Network Analysis, (2nd Ed). Sage.

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC803: ETHICAL HACKING

L	T	P	Cr
3	0	2	4.0

Course Objectives: This course is designed to impart a critical and theoretical and detailed practical knowledge of a range of computer network security technologies as well as network security tools and the services related to Ethical Hacking.

Syllabus

Introduction: Understanding the importance of security, Concept of ethical hacking and essential Terminologies-Threat, Attack, Vulnerabilities, Target of Evaluation, Exploit. Phases involved in hacking. **Footprinting**: Introduction to footprinting, Understanding the information gathering methodology of the hackers, Tools used for the reconnaissance phase.

Scanning: Introduction to scanning tools, Detecting live systems-on the target network, - Discovering services running listening on target systems, Understanding port scanning techniques, Identifying TCP and LIDP services running on the target network, Understanding active and passive fingerprinting.

System-Hacking: Understanding Sniffers, Comprehending Active and Passive Sniffing, ARP Spoofing and Redirection, DNS and IP Sniffing, HTTPS Sniffing.

Session Hijacking: Understanding Session Hijacking, Phases involved in Session Hijacking, Types of Session Hijacking, and Session Hijacking Tools.

Hacking Wireless Networks: Introduction to 802.11, Role of WEP, Cracking WEP Keys, Sniffing Traffic, Wireless DOS attacks, WLAN Scanners, WLAN Sniffers, Hacking Tools, Securing Wireless Networks.

Cryptography: Symmetric and Asymmetric Cryptography, Classical Encryption techniques, Substitution techniques, Block Ciphers Principles, Fiestel Structure, DES, Double and Triple DES, AES, Public Key Cryptography, RSA, Diffie-Hellman Key Exchange, Cryptographic Hash Functions and Digital Signatures.

Laboratory Work Lab Exercises including using scanning tools like IPEYE, IPsecScan, SuperScan etc. and Hacking Tools likes Trinoo, TFN2K, Zombic, Zapper etc.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Understand the different phases involved in hacking.
2. Utilize the scanning tools used for the information gathering.
3. Recognize the phases in session hijacking and use the tools for counter-measuring the various sniffing attacks.

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4. Analyse different types of attacks on the wireless networks.
5. Describe and apply different types of algorithms for securing the data.

Text Books:

1. Simpson T. M., Backman K., Corley J., Hands-On Ethical Hacking and Network Defense, Delmar Cengage Learning (2011) 2nd edition.
2. Fadia A. and Zacharia M., Network intrusion alert: an ethical hacking guide to intrusion detection, Boston, MA: Thomas Course Technology 3rd edition (2008).

Reference Books:

1. Mathew T., Ethical Hacking, OSB Publication (2003). 2nd edition
2. McClure S., Scambray J. and Kurtz G., Hacking Exposed 7: Network Security Secrets and Solutions, McGrawHill (2012) 7th Edition.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC892: DESIGN PROJECT

L	T	P	Cr
-	-	-	8.0

Course Objectives: The design project is introduced in Electrical and Computer Engineering undergraduate programme to include a practical training in the university itself for six months.

Course Description: Course Description: The project offers the student the opportunity to demonstrate engineering theory into practice under the supervision of a faculty supervisor in electrical engineering department. The students are also offered with two courses. The technical activity in the project semester should be related to both the student's engineering studies and the faculty supervisor's guide lines to make working model in the area of application of electrical engineering. It involves tasks and methods that are more appropriately completed in an academic practical environment and should, where possible, make use of human and technology resources provided by the university. It consolidates the student's prior learning and provides a context for later research studies. The student remains a full-time registered student at Thapar University during the project semester and this activity is, therefore, wholly distinct from any industrial interactions which may occur over vacation periods.

Assessment Details: Each student is assigned a faculty supervisor who is responsible for managing and assessment of the alternate project semester. The faculty supervisor guides the students till the end of semester and monitors the student's progress throughout the same. This includes a Reflective Diary which is updated throughout the alternate project semester, an Interim Project Report, a Final Report with Learning Agreement/Outcomes and a Final Presentation & Viva which involves the faculty Supervisor and some other faculty members from the department.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Acquire knowledge and experience of software and hardware practices in the area of project.
2. Carry out design calculations and implementations in the area of project.
3. Associate with the implementation of the project requiring individual and teamwork skills.
4. Communicate their work effectively through writing and presentation.
5. Demonstrate the professional responsibilities and respect for ethics in university ambiance.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC891: PROJECT SEMESTER

L	T	P	Cr
-	-	-	15.0

Course Objectives: The project semester is aimed to facilitate the students learn and apply their acquired skill set for the system development in the domain of Electrical and Computer Engineering. Each individual student will undertake practical training in a professional engineering set up (a company, top educational institution, research institute etc.) hereafter referred to as host "organization" as deemed appropriate. As a part of a team, the students will make a project, which emphasizes hands-on experience, and integrates analytical, design, and development skills.

Course Description: The project semester gives the student the opportunity to translate engineering theory into practice in a professional engineering environment. The technical activity in the project semester should be related to both the student's engineering studies and to the host organization's activities and it should constitute a significant body of engineering work at the appropriate level. It should involve tasks and methods that are more appropriately completed in a professional engineering environment and should, where possible, make use of human and technology resources provided by the organization. The idea is to provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem. It consolidates the student's prior learning and provides a context for later research studies. The student remains a full time registered student at Thapar Institute of Engineering and Technology during the project semester and this activity is therefore wholly distinct from any industrial interactions which may occur over vacation periods.

Assessment Details: Each student is assigned a faculty supervisor who is responsible for managing and assessment of the project semester. The faculty supervisor monitors the student's progress in a semester and interacts with the industry mentor during his/her visit to the host organization twice. The evaluation scheme in the projects semester includes a Reflective Diary which is updated throughout the project semester, a Mid-Way Project Report, a Final Report with Learning Agreement/Outcomes and an End semester Presentation & Viva. Each student will present his/her work to the panel of examiners which involves the faculty Supervisor and some other members from the department. The mentor from the host organization is asked to provide his assessment on the designated forms. The faculty supervisor is responsible for managing and performing the assessment of the project semester experience.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Develop skills necessary for time management, reporting and carrying out projects within an organization/industry.
2. Acquire knowledge and experience of software and hardware practices in the area of project.
3. Carry out design calculations and implementations in the area of project.
4. Associate with the implementation of the project requiring individual and teamwork skills.
5. Communicate their work effectively through technical report writing and presentation.
6. Demonstrate the knowledge of professional responsibilities and respect for ethics

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ULC893: START-UP SEMESTER

L	T	P	Cr
-	-	-	15.0

Course Objectives: The start-up semester is introduced in Electrical and Computer Engineering undergraduate programme to provide training and skills to encourage start-ups among students.

Course Description: Under this six month start-up project semester , the students will learn about the following:

- Fundamentals of 'Entrepreneurship & Innovation'
- Opportunity identification and evaluation, Customer validation
- Developing a Business Model Canvas
- Business Development Process related to the startup, relating theoretical framework with the business idea, Industry dynamics, opportunity canvas and regulatory aspects related to the business idea.
- Design thinking
- Technical development
- Financial management
- Entrepreneurial Marketing
- Interaction with existing Startups and pitching of projects,
- Presentation of Prototype/Working model/useful App or a working Software

Assessment Details: Each student is assigned a faculty supervisor and industry mentor. Faculty supervisor is responsible for managing and assessment of the Startup semester. The faculty supervisor monitors the student's progress in a semester and interacts with the industry mentor during his/her visit to the host organization twice. The semester includes maintenance of a Reflective Diary, which is updated throughout the startup semester, an Interim Project Report, a Final Report with Learning Agreement/Outcomes and a Final Presentation & Viva, which involves the faculty Supervisor, and some other members from the department. The mentor from the host organization is asked to provide the assessment on a designated form. The faculty supervisor is responsible for managing and performing the assessment of the startup semester experience.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Demonstrate an ability to develop a business plan.
2. Carry out design calculations/simulations and implementations in the area of project.
3. Develop a prototype/working model/software application.
4. Comprehend the fundamentals of business pitching.
5. Demonstrate the knowledge of professional responsibilities and respect for ethics.

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ULC511: BATTERY MANAGEMENT SYSTEM

L	T	P	Cr
2	0	2	3.0

Course Objectives: This course delves into the significance of a Battery Management System (BMS) across diverse battery technologies, exploring various potential configurations. Additionally, it delves into the sophisticated functionalities of the BMS, enriching insights into the battery system's status and ensuring its optimal utilization.

Syllabus

Introduction: What is traction battery? Classification of battery, Application of battery in EVs, Evolution of battery applications (Lead-acid, Lithium-ion and Sodium-ion), General Specification of battery pack used in EVs, Affordable and clean energy aspects of EV battery, EV Battery applications for sustainable cities.

Need of Battery-Management-System : Functionality of BMS in EVs, Battery pack sensing: current, voltage and temperature, isolation and thermal control, protection, and interface, SoC, energy and power estimation requirement.

BMS Architecture: BMS topologies: Distributed Topology, Modular Topology and Centralized Topology, Details of Hardware and software architecture, Components of BMS, Master and Slave BMS. Firmware development, Certification, Aging.

Modelling of Battery Packs: Generalized/Standard Equivalent-circuit models, equations of vehicle dynamics, vehicle range calculations.

State Estimation of Battery: Preliminary definitions, Approaches of estimation of SoC and SoH.

Battery Health Estimation: Introduction of Lithium-ion aging: Negative electrode and Positive electrode, sensitivity of voltage to ESR and total capacity, A Kalman filter framework for estimating parameters,RUL.

Cell Balancing: Concept of cell balancing, Causes of imbalance, Design choices when implementing balancing, Circuits for balancing (1): Passive (2): Active, capacitive (3): Active, inductive and dc-dc. Methods of cell balancing.

Laboratory Work Modelling and simulation of battery packs, State Estimation of Battery, Battery Health Estimation, Active and Passive Cell Balancing etc., BMS testing related experiment.

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Course Learning Outcomes (CLOs) /Course Outcomes (COs): On completion of this course, the students will be able to:

1. Design and evaluate Battery Management System architectures and modeling approaches.
2. Demonstrate various techniques for battery state estimation and health assessment.
3. Implement and compare different cell balancing methods.
4. Assess voltage-based power limit estimation techniques.
5. Analyze battery applications in the context of sustainability and environmental impact.

Text Books:

1. Battery Management Systems, Volume II: Equivalent-Circuit Methods by Gregory L Plett, 2016.
2. A Systems Approach to Lithium-Ion Battery Management (Power Engineering) by Phil Weicker.

Reference Books:

1. Battery Modeling Volume I: Battery Modeling (Power Engineering), by Gregory L Plett, 2015.
2. Handbook on Battery Energy Storage System, 2018.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

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ULC512: CLOUD COMPUTING

L	T	P	Cr
2	0	2	3.0

Course Objectives: To learn the concepts of cloud infrastructure and services in addition with its implementation for assessment of understanding the course by the students

Syllabus

Introduction and Evolution of Computing Paradigms: General Benefits and Architecture, Business Drivers, Main players in the Field, Overview of Existing Hosting Platforms and its architecture, Cluster Computing, Grid Computing, XaaS Cloud Based Service Offerings, Green Cloud, Overview of Security Issues, Comparison of different Cloud Service Providers (CSPs).

Classification of Cloud Implementations: Key Amazon offerings-Amazon Web Services, The Elastic Compute Cloud (EC2), Simple Storage Service (S3), Simple Queuing Services (SQS), Bundling Amazon instances, AWS Identity Management and Security in the Cloud, Messaging in the Cloud, RESTFul Web Services.

Virtualization: Virtualization, Advantages and disadvantages of Virtualization, Types of Virtualization: Resource Virtualization i.e. Server, Storage and Network virtualization, Migration of processes, Classic Data Center, Virtualized Data Center (Compute, Storage, Networking and Application), Business Continuity in VDC. VMware vCloud – IaaS, Network virtualization through Software Defined Networks.

Cloud based Data Storage and Processing: Introduction to Hadoop, Hadoop Ecosystem (Pig, Hive, Cassandra and Spark), Introduction No-SQL databases, Map- Reduce framework for Simplified data processing on Large clusters using Hadoop, Data Replication, Shared access to data stores.

Related Technologies: Introduction to Fog Computing and Edge Computing, Usage of Cloud for IoT and Big data analytics.

Self-learning Content: Cloud Issues and Challenges: Cloud models, Cloud computing issues and challenges like Security, Elasticity, Resource management and Scheduling, QoS (Quality of Service) and Resource Allocation, Cost Management and Cloud bursting.

Laboratory Work To implement Cloud, Apache and basics of Hadoop framework, an open source implementation of MapReduce, and its Java API, Hadoop Distributed File System (HDFS). Implementation of RESTFul Web Services. To understand various concepts about virtualization and data storage. To implement few algorithms with the help of MapReduce and some high-level language.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Comprehend the basic concepts and architecture of Cloud computing for sustainable solution.
2. Implement Cloud Services through AWS offerings and Restful web services.

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3. Apply the knowledge of virtualization through different virtualization technologies.
4. Perform operations on data sets using Map Reduce framework, SQL and NO SQL databases.

Text Books:

1. Buyya K, R., Broberg J. and Goscinski M. A., Cloud Computing: Principles and paradigms, MIT Press (2011) 4th ed.
2. Kai Hwang, Geoffrey Fox and Jack Dongarra, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Morgan Kaufmann (2012) 2nd ed.
3. Miller M., Cloud Computing, Que Publishing (2008) 1st ed.
4. Puttini R. and Mahmood Z., Cloud Computing: Concepts, Technology & Architecture, Service Tech press (2013) 1st ed.

Reference Books:

1. Velte A., Velte T., and Elsenpeter R., Cloud Computing: A practical Approach, Tata McGrawHill (2009) 1st ed.
2. Hurwitz J., Bllor R., Kaufman M. and Halper F., Cloud Computing for dummies (2009) 1st ed.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UCS653: DATA MINING AND VISUALIZATION

L	T	P	Cr
2	0	2	3.0

Course Objectives: What is data mining, data mining objectives, data mining process, input-output data knowledge representation and applications, standard data repositories.

Syllabus

Data Pre-processing: Data cleaning, Data transformation, Data reduction, Discretization and generating concept hierarchies, Multidimensional data model

Data Analysis and Classification: Attribute generalization and class comparison, Statistical measures, mining through association rules, pattern mining methods, mining diverse frequent patterns, pattern evaluation, sequential pattern mining, graph pattern mining, constraint-based mining and pattern discovery, text mining examples.

Data Clustering: Issues in clustering, Partitioning methods: k-means, expectation maximization (EM), Hierarchical distance-based agglomerative and divisible clustering,

Data Visualization: Data visualization library and tools, 1D, 2D and 3D charts, Regression plot, Histogram plot, Box and Violin plots, Kernel density estimate plot, Heat maps and clustered matrix, Tree maps;

Visualizing large data: Decision Tree Analysis.

Laboratory Work Related to various topics in the syllabus with latest softwares.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Apply basic concepts and techniques of Data Mining.
2. Develop skills of using data mining libraries for solving practical problems.
3. Gain experience of doing independent study.
4. Present the data traits through different visualization.

Text Books:

1. Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques (Second Edition), Morgan Kaufmann, (2005).
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability & Statistics for Engineers & Scientists, (9th Ed.), Prentice Hall Inc.
3. Trevor Hastie Robert Tibshirani Jerome Friedman, The Elements of Statistical Learning, Data Mining, Inference, and Prediction, (2nd Edn.), Springer, (2014).

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Reference Books:

1. G James, G., Witten, D., Hastie T., and Tibshirani, R., An Introduction to Statistical Learning: with Applications in R, Springer, (2013)
2. John M. Chambers, Software for Data Analysis: Programming with R (Statistics and Computing), Springer
3. Rahlf, Thomas, ata Visualisation with R, Springer, (2019)

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UMC622: MATRIX COMPUTATION

L	T	P	Cr
2	0	2	3.0

Course Objectives: This course aims to provide a platform for the students to use linear algebra in real life. Most of the real life problems are based on computation of eigenvalues and singular values. In this course we stress on the computational methods to compute the same. The Matlab implementation of the methods will be insightful for better understanding. The students are expected to have taken basic and a continuation course in numerical analysis or acquired equivalent knowledge in a different way.

Syllabus Matrix Analysis:

Review of matrices and vector spaces: rank of a matrix, linear dependence and independence, bases and dimensions, linear transformations, range and null space of a matrix, rank-nullity theorem.

Inner product space: Gram Schmidt orthogonalization, dual space and invariant space.
Matrix transformations: similarity transformation, diagonalization of matrices, Householder transformation, QR factorization.
Conditioning of matrices: vector and matrix norms, convergent matrices, condition number of a matrix.
Techniques for finding eigen values: Eigen value problems, spectral stability of matrices, reduction to Hessenberg or tridiagonal form, iterative techniques using Krylov subspace concepts for eigen value problems.

Spectral theory of matrices: spectral decompositions, Gersgorin bounds on eigenvalues, spectrum of perturbed matrices, Schur decomposition theorem.

Singular value decomposition: SVD and their applications.

Real life applications of eigen values and singular values: Discussion of real life problems based on eigen values and SVDs and their application in image processing and big data analysis.

Laboratory Work Matlab experiments will be designed to implement algorithms from the syllabus.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Apply fundamental linear algebra concepts,
2. Evaluate norms of vectors and matrices,
3. Solve eigen value problems using theoretical and computational methods,
4. Apply singular value decomposition,
5. Implement linear algebra algorithms using Matlab.

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Text Books / Reference Books:

1. Kenneth Hoffman and Ray Kunze, Linear Algebra, Pearson India, second edition, 2015.
2. Derek J. S. Robinson, A course in linear algebra with application, World Scientific Press, second edition, 2006.
3. Gene H. Golub and Charles F. Van Loan, Matrix Computations, Johns Hopkins University Press, fourth edition, 2012.
4. Roger A. Horn and Charles R. Johnson, Matrix Analysis, second Edition, Cambridge University Press, 2012.
5. L. N. Trefethen and David Bau, Computational Linear Algebra, SIAM, 1997.
6. Gilbert Strang, Linear algebra and its Applications, fourth edition, CENGAGE, 2014.

Evaluation Scheme

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

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ULC664: CYBER AND NETWORK SECURITY

L	T	P	Cr
2	0	2	3.0

Course Objectives: This course will enable students to know about security concerns in Email and Internet Protocol, understand cyber security concepts, list the problems that can arise in cyber security and discussion about the various cyber security frame work.

Syllabus

Introduction: Introduction to Computer Security, Vulnerabilities, Security Attacks, Security Mechanisms and Principles. Symmetric and asymmetric cryptography, DES, RSA, Diffie Hellman Key exchange, cryptographic hash functions, digital signatures.

Network Security: Network Concepts, Threats to Network Communications, Wireless Network Security, Denial of Service attacks, Buffer Overflow, Spoofing and Sniffing attacks, ARP Poisoning, Cryptography in Network Security, Firewalls, Intrusion Detection and Prevention Systems, Network Management.

Transport Level Security: Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS, Secure Shell (SSH).

E-mail Security: Pretty Good Privacy, S/MIME, Domain keys identified mail.

IP Security: IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP), Combining security Associations Internet Key Exchange. Cryptographic Suites.

Cyber network security concepts: Security Architecture, Anti-pattern: signature-based malware detection versus polymorphic threads, document driven certification and accreditation, policy driven security certifications. Refactored solution: reputational, behavioural and entropy-based malware detection. The problems: cyber anti-patterns concept, forces in cyber anti-patterns, cyber anti pattern templates, cyber security Anti-pattern CatLog.

Cyber network security frameworks: Enterprise security using Zachman framework Zachman framework for enterprise architecture, primitive models versus composite models, architectural problem-solving patterns, enterprise workshop, matrix mining, mini patterns for problem solving meetings.

Case study: Cyber security hands on managing administrations and root accounts, installing hardware, reimaging OS, installing system protection/ antimalware, configuring firewalls

Laboratory Work Demonstrate use of Environment variables and privileged programs, Demonstrate Buffer Overflow and showcase EIP and other register status, insert malicious shell code into a program file and check its malicious or benign status, perform ARP poisoning, implement state ful firewall using IPTables.

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Course Learning Outcomes (CLOs) /Course Outcomes (COs): On completion of this course, the students will be able to:

1. Comprehend and discuss fundamental concepts related to cyber security using cryptographic algorithms to protect the confidential data.
2. Analyze the concepts related to IP Security, Transport layer security, and Enterprise Security using Zachman Framework.
3. Apply cyber network security concepts to locate and fix security leaks in a computer network/software.
4. Identify network vulnerabilities and apply various security mechanisms to protect networks from security attacks.

Text Books:

1. William Stallings, "Cryptography and Network Security Principles and Practice", Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-325- 1877-3.
2. Thomas J. Mowbray, "Cyber Security – Managing Systems, Conducting Testing, and Investigating Intrusions", Wiley.

Reference Books:

1. Cryptography and Network Security, Behrouz A. Forouzan, TMH, 2007.
2. Cryptography and Network Security, Atul Kahate, TMH, 2003

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

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ULC702: INDUSTRIAL COMMUNICATION PROTOCOLS AND SCADA

L	T	P	Cr
3	0	0	3.0

Course Objectives: The objective of this course is to impart strong knowledge about industrial automation, communication technologies and Supervisory Control and Data Acquisition (SCADA) in students, This course includes ndustrial communication protocols, Data Communication basics, network architecture and network protocols, typical SCADA system Architecture, Human machine interface, Properties of SCADA system, features. The course also includes SCADA protocols such as DNP3 protocol control net and applications of SCADA systems.

Syllabus

Industrial Communication Protocols: Introduction to Communication Protocols Data Communication basics, OSI reference model, Network Classification, Device Networks, Control Networks, Enterprise Networks. Introduction to Networks in process automation, Industry Networks, Network selection, Proprietary and open networks.

Network Architecture and Wireless Protocols: Network Architectures, Building blocks, Industry open protocols: RS-232, RS-422, RS-485, Ethernet, Modbus, Profibus, Fieldbus; Hardware: Fieldbus Design, Advantages and Limitations. Introduction to wireless Protocols Wi-Fi, Bluetooth, Overview of IEC 61850 Standard: Data Models, Communication Services.

Supervisory Control and Data Acquisition Systems: Introduction and block diagram of SCADA system, typical SCADA Architectures (First generation-Monolithic, Second generation- Distributed, Third generation–Networked Architecture), Properties of SCADA system , Advantages and limitations of SCADA system, DCS Vs SCADA, Human Machine Interface, SCADA security, Practical modern SCADA protocols: DNP3,60870.5 and related systems, API Std 1164 SCADA Security, Verification of security intelligence for a resilient SCADA system, SCADA system specification.

SCADA Protocols: Open systems interconnection (OSI) models, TCP/IP protocol, DNP3 protocol, IEC61850 layered architecture, Control and Information Protocol (CIP), Device Net, Control Net, Ether Net/IP, Flexible Function Block process (FFB), Process Field bus (Profibus). IEEE recommended practice for Master/Remote SCADA Communications.

Applications of SCADA system: Communication Protocols for Power System Communication requirements and its automation, SCADA systems in operation and control of interconnected power system.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Exhibit understanding of the various industrial communication protocols.
2. Analyze different network architecture.

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3. Conceptualize the functionality of different layers within a SCADA architectures.
4. Elucidate different SCADA protocols.
5. Analyze the challenges and issues in SCADA systems
6. Analyze about power distribution system and study of automation- SCADA

Text Books:

1. Eric Knapp, Joel Thomas Langill, "Industrial Network Security: Securing Critical Infrastructure Networks for Smart Grid, SCADA, and Other Industrial Control Systems", Elsevier, Second Ed., (2015)
2. Mini. S. Thomas and John D. McDonald, "Power System SCADA and Smart Grids", CRC Press, First Ed., (2015).
3. Ronald L. Krutz, "Securing SCADA System", Wiley Publications, (2005)
4. Stuart A Boyer, "SCADA supervisory control and data acquisition", ISA, 4th Revised edition, (2009)

Reference Books:

1. David J Teumim, "Industrial Network Security", 2nd Edition-International Society of Automation ISA, (2010).
2. R. Radvanovsky, J. Brodsky , Handbook of SCADA/Control Systems Security, (2016).
3. B.G. Liptak, Process Software and Digital Network, CRC Press ISA- The Instrumentation, Systems, and Automation Society, 4th Ed., (2011)
4. User Manuals of Foundation Fieldbus, Profibus, Modbus, Ethernet, Devicenet, Controlnet, IEC 61850.
5. Peterson Davie, "Computer Networks—A System Approach", Maugann Kauffmann Publisher 6th Ed., (2021)
6. Fundamentals of Supervisory systems, IEEE tutorial, IEEE Press, (1991)

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

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ULC513: SOFTWARE ENGINEERING

L	T	P	Cr
2	0	2	3.0

Course Objectives: To plan and manage large scale software and learn emerging trends in software engineering.

Syllabus

Software Engineering and Processes: Introduction to Software Engineering, Software Evolution, Software Characteristics, Software Crisis: Problems and Causes, Software process models -Waterfall, Iterative, Incremental and Evolutionary process models, Sustainable Software Lifecycle and Software Development.

Requirements Engineering: Problem Analysis, Requirement Elicitation and Validation, Requirement Analysis Approaches- Structured Analysis Vs Object Oriented Analysis, Flow modeling through Data Flow Diagram and Data Dictionary, Data Modeling through E-R Diagram, Requirements modeling through UML (Scenario, Behavioral and Class modeling), documenting, Software Requirement Specification (SRS).

Software Design and construction: System design principles like levels of abstraction, separation of concerns, information hiding, coupling and cohesion, Structured design (topdown or functional decomposition), object-oriented design, event driven design, component-level design, test driven design, data design at various levels, architecture design, coding Practices.

Software Verification and Validation: Levels of Testing, Functional Testing, Structural Testing, Test Plan, Test Case Specification, Software Testing Strategies, Verification & Validation, Unit and Integration Testing, Alpha & Beta Testing, White box and black box testing techniques, System Testing.

Agile Software Development: Agile Manifesto, Twelve Practices of eXtreme Programming (XP), XP values, XP practices, velocity, spikes, , Adaptive Software Development(ASD), Feature Driven Development (FDD), Test Driven Development, Dynamic System Development Method(DSDM), and Crystal Methodology, Agile Requirement and Design.

Software Project Management: Overview, Scope, Time and Cost estimations.

Laboratory Work Implementation of Software Engineering concepts and exposure to CASE tools like Rational Software Suit through projects.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Analyze software development process models for software development life cycle.

2. Elicit, describe, and evaluate a system's requirements and analyze them using various UML models.
3. Demonstrate the use of design principles in designing data, architecture, user and component level design.
4. Test the system by planning appropriate test cases and applying relevant test strategies.
5. Comprehend the use of agile development methodologies for sustainable software development.

Text Books:

1. Pressman R., Software Engineering, A Practitioner's Approach, McGraw Hill International, 7th ed. (2010).
2. Sommerville I., Software Engineering, Addison-Wesley Publishing Company, 9th ed. (2011)

Reference Books:

1. Jalote P.,An integrated Approach to Software Engineering, Narosa, 3rd ed. (2005).
2. Booch G.,Rambaugh J.,Jacobson I.,The Unified Modeling Language User Guide, 2nd ed. (2005).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UCS532: COMPUTER VISION

L	T	P	Cr
2	0	2	3.0

Course Objectives: To understand the basic concepts of Computer Vision. The student must be able to apply the various concepts of Computer Vision in other application areas. Digital Image Formation and low-level processing.

Syllabus

Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Image Representation & Description: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, LBP and its variants, Gabor Filters and DWT.

Image Segmentation: Region Growing, Edge Based approaches to segmentation, GraphCut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Pattern Analysis: Clustering: K-Means, Fuzzy C-means; Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Dimensionality Reduction: PCA, LDA, ICA.

Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, SpatioTemporal Analysis, Dynamic Stereo; Motion parameter estimation.

Self-Learning Content: Miscellaneous: Applications: CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing; Modern trends - superresolution; GPU, Augmented Reality; cognitive models, fusion and SR&CS.

Laboratory Work To implement various techniques and algorithms studied during course.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Exhibit understanding of the fundamental problems of computer vision.
2. Implement various techniques and algorithms used in computer vision.
3. Analyse and evaluate critically the building and integration of computer vision algorithms and systems.
4. Demonstrate awareness of the current key research issues in computer vision.

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Text Books:

1. Szeliski, R., Computer Vision: Algorithms and Applications, Springer-Verlag London Limited (2011), 1st Edition.
2. Forsyth, A., D. and Ponce, J., Computer Vision: A Modern Approach, Pearson Education (2012) 2nd Edition.

Reference Books:

1. Hartley, R. and Zisserman, A., Multiple View Geometry in Computer Vision Cambridge University Press, 2nd Edition (2003).
2. Fukunaga, K., Introduction to Statistical Pattern Recognition, Academic Press, Morgan Kaufmann, 2nd Edition (1990).
3. Gonzalez, C., R. and Woods, E., R. Digital Image Processing, Addison- Wesley, 4th Edition (2018)

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UCS754: BLOCKCHAIN TECHNOLOGY AND APPLICATIONS

L	T	P	Cr
2	0	2	3.0

Course Objectives: The objective of this course is to provide exposure on blockchain technology and its real-time applications.

Syllabus

Basic Cryptography: Introduction to cryptography and cryptanalysis, Cryptographic issues, cryptographic components, cryptographic techniques, cryptographic categories: symmetric key and asymmetric key cryptography, traditional ciphers, modern ciphers, message integrity, message authentication, key management, digital signatures, entity authentication, ECDSA, ECC, Ring, One time signature, Hashing: SHA-356, SHA-512, TLS and SSL, Timestamp, Public and Private keys, Merkle root hash.

Bitcoin Cryptocurrencies: What is Bitcoin, Brief history of Bitcoin, Bitcoin mining and supply, Bitcoin cryptocurrency (BTC), Traditional centralized vs. decentralized, Bitcoin's blockchain: evolution of blockchain, block header, genesis block, hash generation, Bitcoin address: formats, hash generation, address structure, transactions: multi-signatures, generating transactions, storing data, block verification and validation, block mining.

Smart Contracts: Introduction to smart contracts, smart contracts used in a centralized and decentralized systems, Blockchain platforms using smart contracts: Ethereum, architecture of Ethereum virtual machine, token- ETH, Mining process, ERC- standards, transactions in Ethereum, Hyperledger fabric, Sidechains, NXT, Stellar, R3Conda, Litecoin, Quorum, IBM, Openchain, Eris:db.

Consensus Mechanisms: Double spending problem, BFT, PBFT, PoW, PoS, DPoS, PoA, PoB, PoR, PoET, PoI, PoO, PoSp, PoC, Ripple, Tendermint.

Applications of Blockchain: Financial system, smart grid, healthcare, smart transportation system, e-Governance, education, exchange and trading, online market place, commercial supply chain, food production, drug manufacturing, safety and security.

Laboratory Work Experiments on creating of blockchain, implementation of smart contract on Python, Conda and Ethereum, Solidity.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Create their own blockchain using Block creation and verification
2. Create the smart contracts for transaction execution
3. Evaluate the performance of blockchain in presence of various attacks
4. Develop and validate various security models for real-life applications.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

Text Books:

1. Melanie Swan, "Blockchain: Blueprint for a new economy", Oreilly publications.

Reference Books:

1. Bellaj Badr, Rcihcard Horrocks and Xun Brian Wu, "Blokchain by example", Packt Publications.
2. Fatima Castiglione Maldonado, "Introduction to Blockchain and Ethereum", Packt Publications.

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC665: DEEP LEARNING

L	T	P	Cr
2	0	2	3.0

Course Objectives: The objective of this course is to provide exposure to the students on the advances in learning theories and their applications to real life problems.

Syllabus

Deep Learning Networks: Deep networks for unsupervised and supervised learning, Hybrid deep networks, Gradient-Based Learning, hidden units, architecture design, Stochastic gradient decent, Back-propagation and other differentiation algorithms, Difficulty of training DNNs, Regularization methods (dropout, drop connect, batch normalization).

Convolution Neural Networks: The Convolution Operation, motivation, pooling, Convolution, and Pooling as an infinitely strong prior, Variants of the basic Convolution function, Study of popular pre-trained deep CNN architectures including AlexNet, VGG, Inception, and ResNet, Training and visualizing CNNs.

Sequence Modelling: Recurrent Neural Networks (RNNs), BPTT, Truncated BPTT, Gated Recurrent Units, Long Short Term Memory.

Autoencoders and Generative Models: Autoencoders, Variational Autoencoders and its relationship with PCA, Basics of generative adversial networks (GANs), GAN training, Synthesizing and manipulating images with GANs.

Self Learning Content: Machine Learning Basics: Learning, Under fitting, Over fitting, Estimators, Bias, Variance, Maximum likelihood estimation, Bayesian Statistics, Supervised learning, Unsupervised learning, Reinforcement learning.

Laboratory Work To implement the models included in this syllabus using open source libraries. The students will be encouraged to work on a project related with NLP/Speech Processing/Computer Vision etc.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Illustrate the learning processes and their statistical properties.
2. Design CNN architectures with appropriate regularization.
3. Build RNNs and their variants for sequential data.
4. Exhibit the understanding of working of autoencoders and GANs..
5. Apply deep learning specific open source libraries for solving real life problems.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

Text Books:

1. Ian Goodfellow and YoshuaBengio and Aaron Courville, "Deep Learning", MIT Press, 2016.
2. Michael Nielsen, "Neural Network and Deep Learning", Online Book 2016.

Reference Books:

1. Le Deng and Dong Yu, "Deep Learning: Methods and Applications", Foundations and Trends in Signal Processing, 2013.
2. Charu C. Aggarwal, "Neural Networks and Deep Learning", Springer; 1st ed. 2018.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC621: EV CHARGING INFRASTRUCTURE

L	T	P	Cr
2	0	2	3.0

Course Objectives: To impart the knowledge of EV traction-battery chargers, electric vehicle supply equipment (EVSE), their main components, and charging protocols.

Syllabus

EV charging Infrastructure : Introduction to charging infrastructure for EVs, Components of charging infrastructure. Layout of charging infrastructure, types of power supply equipment, components of EV battery chargers, charging infrastructure challenges. PV based Charging initiatives.

Classification of EV chargers and standards: Classification of chargers based on charging levels, modes, plug types; architecture and specifications of Bharat AC001 and DC001 chargers; standards related to: connectors, communication, supply equipment, EMI/EMC.

AC-DC Converters: Role of front end power-factor-correction (PFC) converters in EV chargers; types of AC-DC converters; working principles, modulation, design, and closed loop control of PFC converters such as: Boost type PFC, active front-end converter, three-phase PFCs; working principles, modulation, design, and closed loop control of single-stage AC-DC PFC converters; G2V, V2X modes of operation for responsible energy consumption and production.

DC-DC Converters: Role of DC-DC converters in EV chargers; types of DC-DC converter used for EV chargers; working principles, modulation, LLC converter, buck-boost converter; high frequency magnetics; soft-switching criteria.

Protocols and Communication: Open charge point protocol (OCPP); Open System Interconnection-Layer-Model (OSI); CAN Communication; testing methodology for EV battery chargers and EVSE.

Laboratory Work : Study of PFC rectifier comprising a diode-bridge and boost converter; PFC rectifier based on active full-bridge; CC/CV based battery charging using buck-boost converter; CC/CV based battery charging); Bidirectional power flow in EV charging system; CAN communication for automotive applications and EV charging.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Exhibit the understanding of components, layout, and challenges of EV charging, including PV-based solutions.
2. Differentiate charger types, modes, and interpret relevant standards.
3. Analyze PFC converters, modulation, and control techniques for EV chargers.
4. Assess converter types, operation, and efficiency in EV charging.
5. Implement OCPP, OSI, CAN, and testing methods for EV chargers.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

Text Books:

1. Per Enge, Nick Enge and Stephen Zoepf , "Electric Vehicle Engineering", Mc Graw Hill (2020).
2. Iqbal Husain,"Electric and Hybrid Vehicles: Design Fundamentals", CRC Press (2021).

Reference Books:

1. Robert W. Erickson, and Dragan Maksimovic "Fundamentals of Power Electronics", 3rd Ed., Springer (2020).
2. Christoph Marscholik and Peter Subke, "Road Vehicles - Diagnostic Communication" University Science Press (2009).
3. Wolfhard Lawrenz, "CAN System Engineering: From Theory to Practical Applications", Springer (2013).
4. Mohan N., Underland T.M. and Robbins W.P., "Power Electronics – Converters, Applications and Design", 3rd Ed., Wiley India (2008).
5. Tom Denton, "Automotive Electrical and Electronic Systems", 5th Edition, Routledge
6. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2012.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC663: CYBER PHYSICAL SYSTEMS

L	T	P	Cr
3	0	0	3.0

Course Objectives: This course introduces students to the design and analysis of cyber- physical systems (CPS). Students will learn about CPS applications, modeling, analysis techniques, formal verification, and the role of machine learning in its control.

Syllabus

Introduction to CPS: Definition and scope of CPS, applications (Smart grids, autonomous vehicles, industrial automation, and healthcare systems), key features (Integration, feedback loops, real-time behavior), and CPS challenges, Design issues with sensors and actuators (calibration, nonlinearity, sampling, noise) in CPS.

Model based design of CPS: Concept of Modeling of continuous and discrete dynamical systems, hybrid automata, stability verification, reachability, examples, and case study.

Formal Verification: Introduction to reactive systems, temporal logic model checking, formal verification, linear temporal logic (LTL), and key LTL properties.

Learning and Control: Data-driven control approach, concept of reinforcement learning, policy optimization, Q-learning, and actor-criticism method.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Explain the key features and challenges of CPS.
2. Model hybrid systems in CPS using hybrid automata and stability verification.
3. Apply formal methods to verify CPS correctness.
4. Design CPS prototypes using abstraction, invariants, and system composition principles.
5. Implement reinforcement learning techniques for CPS control.

Text Books:

1. Platzer, A. Foundations of Cyber-Physical Systems. Lecture Notes, Computer Science Department, Carnegie Mellon University. (2016).
2. Sayan Mitra, Verifying Cyber-Physical Systems, A Path to Safe Autonomy, MIT Press, 2021.

Reference Books:

1. Alur, Rajeev. Principles of Cyber-Physical Systems. MIT Press, (2015)
2. Peter Marwedel, Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, Springer; 2nd Edition. edition (2010).

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Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

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UEE525: DATA ANALYTICAL METHODS

L	T	P	Cr
2	0	2	3.0

Course Objectives:

Data Analytics is the science of analysing data to convert information to useful knowledge. This knowledge could help the students understand our world better, and in many contexts enable us to make better decisions. This course seeks to present the students with a wide range of data analytic techniques and is structured around the broad contours of the different types of data analytics, namely, descriptive, inferential, predictive, and prescriptive analytics.

Syllabus

Introduction: Data definitions and Analysis techniques, Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing.

Data Cleaning: Organizing,merging and managing the data,Obtain usable data from the web,APIs, and databases, Understand common data storage systems.

Statistical Interference: Review of probability,random variables,expectations,Measures of central tendency, Measures of location of dispersions, Statistical hypothesis generation and testing, Correlation analysis, Maximum likelihood test, confidence intervals.

Exploratory Data Analytics: Regression analysis, Classification techniques, Clustering, Multivariable regression, Investigate analysis of residuals and variability, Understand ANOVA and ANCOVA model cases.

Data Visualization: Dimension reduction, graphical displays of very high dimensional data, Understand analytic graphics and Visualization.

Advancement in Data Analytics: Big data storage, bog data warehouse, big data on cloud, Scalable and parallel computing concept, advanced graphing systems such as the Lattice system.

Case study on smart cities based on data analytics: Assessment of smart meters implementation, Optimal placement of clean energy sources in smart city based on data analytics etc.

Laboratory Work Fundamentals of Python and associated Libraries NumPy, Pandas, Matplotlib; Implement central tendency measures, Analysis of Variance - one-way and two-way ANOVA, Hypothesis testing; Implement linear regression, K-means clustering, Binary classification; Visualization of data; different plots including density plots, box-plot, heat map, area plot.

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

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

1. Analyze data by utilizing clustering and classification algorithms
2. Analyze big data and create statistical models
3. Explore advanced level of understanding of the usage of big data in real world

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

4. Comprehend the concepts of advancement in big data analytics

Text Books:

1. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press,2012.
2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann/El sevier Publishers,2013.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

ULC742: DIGITAL CONTROL SYSTEMS

L	T	P	Cr
3	0	0	3.0

Course Objectives: To present the basic concepts on analysis and design of sampled data control system and to apply these concepts to typical physical processes.

Syllabus

Introduction to discrete time control system : Principle features of discrete time control system, Mathematical analysis and sampling process, quantizing and coding, Data acquisition, conversion and distribution system, Reconstruction of original signal from sampled signal

The Z-Transform: Fundamentals of Z-transform, Important properties and theorems of the Z-transform, Z-transform from the convolution integral, Inverse Z-transform, Direct Division, Partial Fraction, Inversion Integral, Z-transform method for solving difference equation

Analysis of discrete time control system : S-plane to Z-plane mapping and Vice-versa, Stability analysis of closed loop systems in the Z-plane, Discrete time equivalents of continuous time systems, Discrete time equivalents of analog controllers, Transient and steady state response analysis

Design and compensation of discrete time control system : Digital filters: structure, implementation, frequency response, applications, Control system controllers: structure, hardware/software features, responses to control signals, use of root locus and frequency domain concepts, Phase lead and phase lag compensator design for discrete time system, PID controller design and selection of parameters for discrete time system

Discrete time state equations : State space representation of discrete time systems, Discretization of the continuous time state space equation, Pulse transfer function matrix, Stability assessment from the discretized state space equations

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Analyze signals in both time domain and Z domain.
2. Analyze transient and steady state behaviors of linear discrete time control systems
3. Analyze the stability of digital control systems
4. Design digital controllers/compensators and assess their design through the constraint specifications, and decide whether their initial design is acceptable or can be improved.
5. Determine input and output sequence of state space represented discrete time systems.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

Text Books:

1. Ogata K., Discrete Time Control Systems, 2nd Ed., Prentice Hall, Englewood Cliffs, New Jersey, (1995).
2. Charles L. Phillips, Digital Control System: Analysis and Design, Prentice Hall, Englewood Cliffs, New Jersey (1985)
3. Kuo, B.C., Digital Control Systems, The Oxford Series, 2nd Ed., (1995).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UCS636: 3D MODELLING AND ANIMATION

L	T	P	Cr
2	0	2	3.0

Course Objectives: To develop the skill & knowledge in 3D Modeling & Animation. Students will understand the know-how and can function either as an entrepreneur or can take up jobs in the multimedia and animation industry, video studios, edit set-up and other special effects sectors.

Syllabus

3D Object Modelling: Basic modelling concepts, vertices, edges, and faces, basic transformations, pivot points, duplication and merging, extrusion, insetting, modifiers, loop cuts and face loops, subdivision methods, coordinate system and exporting, model rendering.

Low Poly Models: Triangular meshes, objects and mesh data, cursor and origins hidden geometry, Boolean modifiers, geometry from curve, curve resolution, non-planner geometry.

3D Character Modelling: Introduction, character modelling, unwrapping UVs & mapping texture, texture painting, armatures, character rigging, constrained movements, forward and inverse kinematics, time-line, keyframes, character animation, animation rendering.

Physically Based Modelling and Animation: Introduction, Simulation Foundation, Particle based Models, Collision detection and response, Particle System, Particle Simulation, Particle Rendering, Numerical Integration in Particle System, Deformable Meshes, Rigid Bodies and Constrained Dynamics, Fluid Simulation.

Self-Learning Content: Real Time Animation: Splines and curves, Key-frame techniques, Quaternions for rotations / orientations, Blending and interpolation, Kinematics, Motion capture systems, Motion graphs and character control, Animation data representations, Behavioural Animation, Facial Animation, Perception in animation.

Laboratory Work This course covers beginner to intermediate 3D Modeling and Animation. In this Lab the students will be able to model the 3D character and objects, its UV Mapping, Texture Painting, Rigging, and Animation. Evaluation will be mainly via projects and assignments taking a creative approach to expressive 3D modelling and Animation.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Apply modelling concepts in order to implement 3D objects. (Blender / Max).
2. Exhibit the understanding of the basic geometry and triangulation techniques behind low poly models.
3. Implement 3D humanoid characters and to apply the concept of rigging for animating the character using key frames.
4. Illustrate the theoretical and practical aspects of 3D Modelling, Key Frame Animation, Simulation & effects.

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5. Demonstrate different types of animation and its effects in the real world.
6. Analyse the different processes, post processes involved in computer animation field

Text Books:

1. House, H., D. and Keyser, C., J., Foundations of Physically Based Modeling and Animation, CRC Press (2017) 1st Edition.
2. Chopine, A., 3D Art Essentials: The Fundamentals of 3D Modeling, Texturing, and Animation, Focal Press (2011) 1st Edition.
3. Zeman, B., N., Essential Skills for 3D Modeling, Rendering, and Animation, A K Peters / CRC Press (2017) 1st Edition.

Reference Books:

1. Villar, O., Learning Blender: A Hands-On Guide to Creating 3D Animated Characters, Addison Wesley (2017) 2nd Edition.
2. Kerlow, I., The Art of 3D Computer Animation and Effects, Wiley, (2009) 4th Edition.
3. Flavell, L., Beginning Blender: Open Source 3D Modelling, Animation, and Game Design, Apress, (2010) 1st Edition.
4. Boardman, T., 3dsmax 7 Fundamentals, New Riders, (2005) 1st Edition.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC744: FACTS AND CUSTOM POWER

L	T	P	Cr
3	0	0	3.0

Course Objectives: This course aims to learn the concept of power flow control through various power electronic controllers including state of art Flexible AC Transmission System (FACTS) controllers their operational aspects and their capabilities and their integration in power flow analysis so as to understand the basic concepts of power quality.

Syllabus

Basics of Transmission System And Facts Controllers: Reactive power flow control in Power Systems Control of dynamic power un-balances in Power System. Power flow control Constraints of maximum transmission line loading, Benefits of FACTS Transmission line compensation. Uncompensated line, Shunt compensation Series compensation , Phase angle control. Reactive compensation at transmission and distribution level.

Shunt Compensation: Passive shunt compensation: TCR-SC, TCR, TSR, TSC, TCR-SC, Description of Static versus passive VAR compensators, SVC and STATCOM - Operation and control of STATCOM, Comparison between shunt compensators.
Series Compensation: Basic characteristics, working principles, Impedance type series compensation, working of TCSC, TSSC, SSSC, Active Series Compensators: operating principles, SSSC, DVR operations.

Unified Power Flow Controller: SSR and its damping Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPFC. Basic Principle of P and Q control, Applications

Interline Power Flow Controller: Principle of operation, Control and characteristics, Model of IPFC for power flow and optimum power flow studies.

Power Quality Issues And Application of Custom Power Devices: Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners- IEEE standards on power quality, Application of FACTS devices for power-flow control and stability improvement. Example of power swing damping in a single-machine infinite bus system using a TCSC. Example of voltage regulation of transmission mid-point voltage using a STATCOM. PQ and PQ problems, PQ integration using DSTATCOM, DVR and UPQC

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Analyze the performance of Transmission line with and without FACTS Devices
2. Compare the SVC and STATCOM.
3. Exhibit the understanding of the operation and control of various FACTS devices.
4. Develop various mathematical models of FACTS devices for applications in power system networks.

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5. Distinguish various power quality issues and how are they mitigated by various custom power devices.

Text Books:

1. Hingorani, N. G. and Gyugyi, L., Understanding FACTS: Concepts and Technology of FACTS Systems, Wiley-IEEE Press, (1999).
2. Padiyar K. R., FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd. , (2007).

Reference Books:

1. Song, Y.H. and Johns, A.T., Flexible AC Transmission Systems, IEEE Press (1999).
2. T. J. E. Miller, Reactive Power Control in Electric Systems, John Wiley and Sons, New York, 1983.
3. Zhang, X. P., Rehtanz, C. and Pal, B., Flexible AC Transmission Systems: Modelling and Control, Springer (2006).
4. G. T. Heydt, Electric Power Quality, Stars in a Circle Publications, 1991.
5. Thomas, Mini S., McDonald. John D, Power System SCADA and Smart Grids, CRC Press, (2015)
6. Abur A. and Exposito A. G.. Power System State Estimation: Theory and Implementation, Marcel and Dekker Ink, (2004).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC741: ADVANCED METERING INFRASTRUCTURE

L	T	P	Cr
3	0	0	3.0

Course Objectives: To get acquainted with the concepts of smart grid components. To understand the concept of AMI with fundamental component. To apply the various techniques of communication, computer networking and cyber security for smart metering systems.

Syllabus

Fundamentals of Smart Grids: Existing power grid and its evolution with modernization, Concept of Smart Grid, Need of Smart Grid, Applications of Smart Grid to power systems, Different components of Smart Grid, Role of Intelligent Energy Network, Advanced Metering Infrastructure (AMI).

Advanced Metering Infrastructure (AMI): Detailed concept of Smart Grid and benefits, Basic concept and components of AMI, Challenges faced by AMI, Technologies and topologies of Automatic Meter Reading (AMR) and explain that smart meter is an impending entry point, Security Issues faced by AMI.

Fundamental component of AMI: Role of Smart Meter installed at subscribers' premises, focus on in-home security vulnerabilities of Smart Meter, and Energy Theft susceptibilities, and Smart Metering Programs based on enhanced cryptographies.

AMI protocols: Standards and initiatives, Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

Elements of communication, networking and interfacing: Architectures, standards, PLC, Zigbee, GSM, BPL, Local Area Network (LAN) - House Area Network (HAN) - Wide Area Network (WAN) - Broadband over Power line (BPL) - IP based Protocols - Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

Fundamentals of Cyber Security: Types of Security Attacks and Threats, Model of Cyber Security and Security Protocols for Smart Grid. Highlight Information Assurance Fundamentals (such as Authentication, Authorization, Integrity, Confidentiality, and Non Repudiation, etc

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Elucidate the concept of smart grid electricity network.
2. Exhibit the knowledge of fundamental elements of AMI and its protocols.
3. Comprehend the communication technologies involved and security aspects.
4. Identify network vulnerabilities and apply various security mechanisms to protect Smart Grids from security attacks.

Text Books:

1. Gerardus Blokdyk, Advanced Metering Infrastructure (AMI), 3rd Ed., (2018).

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

Reference Books:

1. Gellings, C.W., The Smart Grid: Enabling Energy Efficiency and Demand Response, CRC Press, (2009).
2. Ekanayake J., Jenkins, N., Liyanage K., Smart Grid: Technology and Applications, Wiley, (2012).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC731: GRID SECURITY

L	T	P	Cr
2	0	2	3.0

Course Objectives: This course will introduce the students about the investigate key concepts behind electric grid security that includes cyberattack, vulnerability assessment and the Intrusion Detection System (IDS) development.

Syllabus

Introduction to grid security: Study of electric grids as a cyber-physical systems, key smart grid security challenges (physical and cyber), different cyber-attack events and their analysis (Ukrainian attack, STUXNET), current security initiatives

Types of attack: Cyber-attacks definition, their types, Strategic attack, template attack, location attack, modelling of attack (Time delay attack, denial of service attack)

Vulnerability assessment: Vulnerability assessment of different types of cyber-attack, case study in PMU, automatic generation control, economic load dispatch problems

Attack detection and prevention: State estimation methods, Observer-based different faulty data detection methods and AI-based schemes

Metrics for electricity sectors: Study of different metrics and protocols to evaluate and benchmark resilience, framework recommendations and technology evaluations.

Laboratory Work Computer simulations related to modelling of the cyberattacks, analysis and detection methods of electric systems (automatic generation control/PMU systems economic load dispatch problem).

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Exhibit the knowledge of different types of cyber-attack in electric grids.
2. Comprehend and model cyber attacks.
3. Analyze the effects of cyber attack.
4. Apply grid resiliency methods according to standards for different scenar- ios.

Text Books:

1. Borlase Stuart. Smart Grid: Infrastructure, Technology and Solutions, CRC Press, (2012).

Reference Books:

1. Resilience Framework, Methods, and Metrics for the Electricity Sector (TR83), IEEE PES report.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

2. Thomas, Mini S., McDonald. John D, Power System SCADA and Smart Grids, CRC Press, (2015)

3. Abur A. and Exposito A. G.. Power System State Estimation: Theory and Implementation, Marcel and Dekker Ink, (2004).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC643: FORECASTING METHODS AND APPLICATIONS

L	T	P	Cr
3/2	0	0/2	3.0

Course Objectives: This course aims to impart the depth-in-knowledge about the concepts of forecasting regression and economic methods, fundamentals of ARIMA time-series model and will learn the concept of advanced forecasting models.

Syllabus

Introduction: An overview of forecasting techniques, Explanatory versus time series forecasting, Qualitative forecasting, Basic steps in a forecasting task, Basic forecasting tools: Time series and cross-sectional data, Graphical summaries, Numerical summaries, Measuring forecast accuracies, Prediction intervals, Transformations, and adjustments

Smoothing and Decomposition Time Series Methods: Smoothing Methods: Averaging methods, Exponential smoothing methods, Other smoothing methods, Comparison of methods, General aspects of smoothing methods, Development of the mathematical basis of smoothing methods, Decomposition methods: Principles of decomposition, Moving average and its types, Classical decomposition method.

Regression and Economic Methods: Types of regression Methods, Least-squares estimation, Correlation coefficient, Cautions in using correlation, Simple regression, and the correlation coefficient, Residuals, outliers, and influential observations, Correlation and causation, Multiple regression: Introduction to multiple linear regression, selecting independent variables and model specification, Multiple regression and the coefficient of determination, Assumptions behind multiple linear regression models

Box Jenkins (ARIMA) Time-Series Model: Fundamentals of Time-series Analysis, The Box Jenkins Methods: identification, Estimation of parameters, Diagnostic checking, Load forecasting with ARIMA Model

Advanced Forecasting Models: Dynamic regression models: Basic forms of the dynamic regression model, Forecasting, Koyck Model Applications of Forecasting Techniques for load forecasting, solar energy forecasting

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Exhibit the knowledge of fundamentals of forecasting techniques.
2. Apply smoothing and decomposition time-series methods.
3. Comprehend & Compare various types of regression and economic methods.
4. Apply ARIMA time-series model in Load forecasting
5. Analyze, model, and implement advanced models in load forecasting.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

Text Books:

1. Markakis, S.G., Steven C. Wheelwright, Rob J Hyndman, Forecasting: Methods and Applications, Wiley Press, (1997).
2. Boylan John E., Syntetos Aris A., Intermittent Demand Forecasting: Context, Methods, and Applications, Wiley Press, (2022).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC745: MODERN PROPULSION SYSTEM AND ROBOTICS

L	T	P	Cr
2	0	2	3.0

Course Objectives: This course aims to provide an in-depth knowledge about propulsion systems of electric vehicles and on robots for their control and design.

Syllabus

Vehicle Propulsion model: Dynamic model of a vehicle, tractive force. Fundamental of propulsion, power transmission and brake system of an electric /hybrid vehicle: Sizing of the traction system in electric and hybrid vehicles, Power transmission in Electric and Hybrid Vehicles, Braking and Energy recovery in Electric and Hybrid Vehicle. Standard conduction cycles.

Introduction to Robotics: Types and components of a robot, Classification of robots, closed-loop and openloop control systems, Kinematics systems; Definition of mechanisms and manipulators.

Robot Kinematics and Dynamics: Direct kinematics problem, The inverse kinematics solution, DH parameters, Lagrange-Euler formation, Generalized D'Alembert equations of motion, Denavit Hartenberg convention and its applications.

Sensors and Vision System: Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Cameras and their calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations, Vision applications in robotics.

Robot Actuation Systems: Motor control for mobile robots, Servo control for robotic arms, Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators

Laboratory Work Study components of a real robot and its DH parameters. Forward kinematics and validate using a software (Robo Analyser). Inverse kinematics of the real robot and validation using any software, Use of open source computer vision programming tool openCV. Positioning and orientation of robot arm, Integration of assorted sensors (IR, Potentiometer, strain gages etc.), micro-controllers and ROS (Robot Operating System)

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Perform kinematic and dynamic analyses with simulation.
2. Design control laws for a robot.
3. Integrate mechanical and electrical hardware for a real prototype of robotic device.
4. Select a robotic system for given application.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

Text Books:

1. J. M. Miller, Propulsion Systems for Hybrid Vehicles, 2nd Edition, (2010)
2. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, (2014).
3. Ghosal, A., "Robotics", Oxford, New Delhi, (2006).
4. Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", PHI, New Delhi.
5. Mittal R.K. and Nagrath I.J., "Robotics and Control", Tata McGraw Hill.
6. Craig, J.J., Introduction to Robotics: Mechanics and Control, Pearson, New Delhi, (2009)

Reference Books:

1. I. Husain, Electric and Hybrid Vehicles: Design Fundamentals, 2nd Edition, (2010)
2. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modelling and Control, John Wiley and Sons Inc, (2005)
3. Steve Heath, Embedded System Design, 2nd Edition, Newnes, Burlington, (2003)
4. Merzouki R., Samantaray A.K., Phathak P.M. and Bouamama B. Ould„ Intelligent Mechatronic System: Modeling, Control and Diagnisis, Springer 2013.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

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UMA038: OPTIMIZATION AND HEURISTICS

L	T	P	Cr
2	0	2	3.0

Course Objectives: 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 classical optimization techniques, non-linear programming, heuristic techniques and multi-objective optimization.

Syllabus

Introduction to Optimization Technique: Introduction, Engineering application of optimization, Statements of optimization problem, Classification of optimization problems.

Classical Optimization Techniques: Introduction, Solution approaches for single and multi-variable optimization problem with equality and inequality constraints, Linear programming (LP), Solution of LP by simplex method, Duality theory, and Dual simplex method.

Non-Linear Programming: Introduction, Interpolation methods: quadratic interpolation method, Direct root methods (Newton method, Quasi-Newton method), Direct search methods, Indirect search methods.

Heuristic Techniques: Introduction, Comparison with conventional techniques, evolutionary techniques, Genetic algorithm, Particle swarm optimization, Ant colony optimization.

Constraint Handling Techniques: Constraint handling approaches, Challenges, issues and perspective, Constraint handling with metaheuristics

Multi-objective Optimization: Introduction, Principles of Multi-objective Optimization, Dominance and Pareto-Optimality, constrained multiobjective optimisation evolutionary algorithms

Applications of Engineering Optimisation in areas like power system operation planning, optimal power flow, pricing, automatic generation and control etc.

Laboratory Work Implementation of classical and heuristic optimization techniques to solve single objective and multi-objective constrained optimization problems in the area of power system operation like economic load dispatch, optimal power flow, electricity pricing etc.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Solve optimization problems using classical optimization techniques.
2. Solve optimization problems using non-linear programming techniques.

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3. Apply heuristic techniques to solve complex optimization problems.
4. Exhibit the knowledge of the principles of multi-objective optimization.

Text Books:

1. Rao S.S., Engineering Optimization, Theory and Practice, John Wiley & Sons Inc. Fourth Edition, (2009).
2. Deb. K., Multi-Objective Optimization using Evolutionary Algorithms, Wiley, (2001)

Reference Books:

1. Nash S.G., Sofer A., Griv I., Linear And Nonlinear Optimization, Second Edition, SIAM, (2017).
2. Kothari D.P., Dhillon J.S., Power system Optimisation, PHI Learning, 2nd ed., (2011)
3. Bazaarra Mokhtar S., Jarvis John J. and Shirali Hanif D., Linear Programming and Network flows, John Wiley and Sons, (1990).
4. Swarup, K., Gupta, P. K., Mammohan, Operations Research, Sultan Chand & Sons, (2010).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

UCS751: SIMULATION & MODELLING

L	T	P	Cr
2	0	2	3.0

Course Objectives: To become familiar with fundamentals of creating mathematical model of physical systems and their simulation for analysis.

Syllabus

Introduction to Modeling and Simulation: Basic concept of Simulation, Advantages, Disadvantages, Applications of simulation, limitation of simulation, Model and types of models, modeling and simulation, Continuous and discrete simulation, analog and digital simulation, System environment, components of a system, steps in a simulation study, Simulation of Queuing and Inventory System.

Random Numbers generation: Pseudo-random generators, Testing of Pseudo-random number generators, Generation of non-uniformly distributed random numbers. Parallel process modeling: Using Petri nets and finite automata in simulation, Cellular automata and simulation.

Simulation Experiments: Run length of Static and Dynamic Stochastic Simulation Experiments, Minimizing variability in simulators without increasing Number of simulation Runs.

Design of Simulators: Design of Application Simulators for Multi-server Queuing System, PERT, Optimizing Inventory Policy and Cost in Business environment.

Input Modeling: Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis. Verification and Validation of Model: Model Building, Verification, Calibration and Validation of Models.

Output Analysis: Types of Simulations with Respect to Output Analysis, Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations.

Self-Learning Content: Different Simulation Softwares and their applications for different analysis, Trends in Simulation Software.

Laboratory Work To carry out work on any simulation tools, Implementation of various techniques to generate random numbers. Apply any simulation model in real life applications.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Elucidate the role of various elements of discrete event simulation and modeling paradigm.
2. Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.

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3. Generate and test random number variates and apply them to develop simulation models.
4. Interpret the model and apply the results to resolve critical issues in a real-world environment.
5. Classify various simulation models and their usage in real-life applications.

Text Books:

1. Payne A. J., Introduction to Simulation: Programming Techniques and Methods of Analysis, Mc-Graw Hill (1982).
2. Gorden G., System Simulation, Prentice Hall publication (1978), 2nd ed.

Reference Books:

1. Narsingh D., Systems Simulation with Digital Computer, PHI Publication (EEE) (2004), 3rd ed.
2. Banks J., Carson J. S., Nelson L. B., Nicol M. D, Discrete Event system Simulation, Pearson Education, Asia (2010), 5th ed.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

UCS646: GAME DESIGN & DEVELOPMENT

L	T	P	Cr
2	0	2	3.0

Course Objectives: To become familiar with various fundamental and advanced gaming concepts including basic maths and physics used behind the game engine.

Syllabus

Introduction: Types of games, History, Impact of Games on Society , Game life cycle, Game loop, Components of game, Model and scene rendering, State Management, Scene management, Texture compression, Level of details, Frustum culling, Occlusion culling, Game as a software, Steps for Game Design, Data Structure for Game, CPU vs.GPU, Game Engine, Components of game engine, Linear Transformation. Composite transformation.

Fundamental Gaming concepts: Static and Dynamic Game objects, Vectors, Concept of Time, Lighting, Particle System, Collider, Collision handles, Materials, Texture mapping, Input Process, Object replication, Instantiation, Special Effects, Terrain, Audio design and production, Ray Casting.

Maths behind Game Engines: Introduction to Vectors- Addition & Subtraction, Vector length, Scaling, Unit length vectors, Dot & Cross product, Linear Interpolation, Euler Angles, Intersection, Matrices, Coordinate systems, Projections, Triangle Meshes, Optimizations, Quaternion.

Advanced Games: Augmented Reality, Virtual Reality, Mixed Reality, AR & VR based Games, Artificial Intelligence based Game, Networking based game, Android based games, Debugging mode, Understanding of Screen and World Coordinate system, Raycasting, Touch & Swipe Input: Touch in Orthographic view, Touch in Perspective view, Accelerometer input, Scaling of Game screen, AR/VR/Android/iOS/Windows Game Deployment methods.

Self-Learning Content: Game Physics: Mathematical concepts, Basic transformations, Collision Detection and response, Newton's law of motion, Modeling gravity, Air resistance, Unstable rotation, Inertia tensor, Moment of Inertia, Applying torque to rigid body, The Magnus effect, Overview of friction, Critical angle, Dynamic Friction.

Laboratory Work 2D and 3D game development for windows and android platform using Unity 3D Game Engine and C# language.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Illustrate the basic concepts, requirements and processes of game design and development
2. Implement the fundamental gaming concepts to create a game.
3. Exhibit the understanding of the physics and mathematics behind the game engine.
4. Demonstrate the advanced gaming concepts such as AR, VR, Android etc.
5. Develop a 2D/3D game using C# and Unity 3D Game engine

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

Text Books:

1. Eberly H. D., Game Physics, Morgan Kaufmann Publisher (2010), 2nd ed.
2. Bond G. J., Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#, Addison-Wesley (2015), 2nd ed.

Reference Books:

1. House H. D., Keyser C. J, Foundations of Physically Based Modeling and Animation, CRC Press (2017), 1st ed.
2. Okita. A., Learning C# Programming with Unity 3D, CRC Press (2014), 1st ed.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

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UCS635: GPU COMPUTING

L	T	P	Cr
2	0	2	3.0

Course Objectives: To study architecture and capabilities of modern GPUs and learn programming techniques for the GPU such as CUDA programming model.

Syllabus

Introduction: Heterogeneous Parallel Computing, Architecture of a Modern GPU, Speeding Up Real Applications, Parallel Programming Languages and Models.

History of GPU Computing: Evolution of Graphics Pipelines, The Era of Fixed-Function Graphics Pipelines, Evolution of Programmable Real-Time Graphics, Unified Graphics and Computing Processors, GPGPU, Scalable GPUs, Recent Developments, Future Trends.

Introduction to Data Parallelism and CUDA C: Data Parallelism, CUDA Program Structure, A Vector Addition Kernel, Device Global Memory and Data Transfer, Kernel Functions and Threading.

Data-Parallel Execution Model: CUDA Thread Organization, Mapping Threads to Multidimensional Data, Matrix-Matrix Multiplication—A More Complex Kernel, Synchronization and Transparent Scalability, Assigning Resources to Blocks, Thread Scheduling and Latency Tolerance.

CUDA Memories: Importance of Memory Access Efficiency, CUDA Device Memory Types, A Tiled Matrix – À Matrix Multiplication Kernel, Memory as a Limiting Factor to Parallelism.

An Introduction to OpenCL: Data Parallelism Model, Device Architecture, Kernel Functions, Device Management and Kernel Launch, Electrostatic Potential Map in OpenCL.

Parallel Programming with OpenACC: OpenACC Versus CUDA C, Execution Model, Memory Model, Basic OpenACC Programs, Parallel Construct, Loop Construct, Kernels Construct, Data Management, Asynchronous Computation and Data Transfer. **Self-Learning Content:** Basics of Parallel and distributed Computing, CUDA programming model

Laboratory Work Practice programs using CUDA, OpenCL and OpenACC.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Comprehend commonly used terms in parallel computing.
2. Exhibit the understanding of common GPU architectures and Programming Models.
3. Implement algorithms efficiently for common application kernels.
4. Develop efficient parallel algorithms to solve given problems.

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

Text Books:

1. Sanders, J. and Kandrot, E., CUDA by Example: An Introduction to General-Purpose GPU Programming, Addison-Wesley Professional (2012) 4th Edition.
2. Kirk, D. and Hwu, M., W., Programming Massively Parallel Processors: A Hands-on Approach. Morgan Kaufmann (2016) 3rd Edition.
3. Grama, A., Gupta, Karypis, G., Kumar, V., Introduction to Parallel Computing, Addison Wesley, (2003) 2nd Edition.

Reference Books:

1. Hwu, M., W., A GPU Computing Gems Emerald Edition (Applications of GPU Computing Series), Morgan Kaufmann (2011) 1st Edition.

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

ULC641: AUTONOMOUS MOBILITY

L	T	P	Cr
3	0	0	3.0

Course Objectives: The goal of the course is to introduce students to the various technologies, the basics of automotive electronics, fundamentals of electronic control systems, and the evolution of these systems will be presented.

Syllabus

Understand Mobility And Its Evolution: Transportation Systems, Mobility and Ways of Life, Electric Mobility: Actual Changes Brought on by Electric Vehicles in Terms of Mobility Systems

Autonomous Cars: Introduction, Why Autonomous, Requirements, Software Architecture, Hardware Architecture.

Electric Mobility Technology: Introduction to electro-mobility, working of an e-car, the development of electro-mobility to the present day, Advantages of electro-mobility, Challenges facing electro-mobility, The e-car of the future.

Electric Vehicles & E Mobility: Electric Cars, Charging Infrastructure, Electric Grid, Battery Technology, Electric Vehicles Policies, Transport Modes Electrification, EV Business Models.

Drones Technology & Setup: Software & Simulated Drones, Main Components, Building Unmanned Vehicles, UAV Simulation, UAV Control.

Autonomous Robots: Introduction to the fundamentals of mobile robotics, examining the basic principles of locomotion, kinematics, sensing, perception, and cognition that are key to the development of the autonomous mobile robot.

Course Learning Outcomes (CLOs) /Course Outcomes (COs):
On completion of this course, the students will be able to:

1. Elucidate the rationale and evolution of automotive electronics.
2. Comprehend the concept of fully autonomous vehicles.
3. Exhibit the knowledge of various aspects of drone technology.
4. Justify the utility of specific Mobile Robots in various application areas.

Text Books:

1. Gerardus Blokdyk, Advanced Metering Infrastructure (AMI), Third edition, (2018)

Reference Books:

1. Clark W. Gellings, The Smart Grid: Enabling Energy Efficiency and Demand Response, CRC Press, (2009).

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.

2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Smart Grid: Technology and Applications, Wiley, (2012).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST) and End Semester Examination (ESE)	**70**
Sessional may include assignments, regular lab assessment, quizzes, and minor projects (report, presentation etc.)	**30**

Approved in 109 th meeting of the Senate held on March 16, 2023. Revised in 112 th and 114 th meeting of the Senate held on March 11, 2024 and March 7, 2025, respectively.