Thapar Institute of Engineering & Technology, Patiala

COURSES SCHEME

FOR

BE (COMPUTER SCIENCE & BUSINESS SYSTEMS)

2023

SEMESTER-I

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT101	DISCRETE MATHEMATICS	CP	3	1	0	3.5
2	UCT102	PROBABILITY AND STATISTICS	CP	3	0	0	3.0
3	UCT104	FUNDAMENTALS OF COMPUTER SCIENCE	CP	3	0	2	4.0
4	UEE002	PRINCIPLES OF ELECTRICAL ENGINEERING	CF	3	0	2	4.0
5	UPH014	PHYSICS FOR COMPIUTING SCIENCE	CF	3	1	2	4.5
6	UHU011	BUSINESS COMMUNICATION & VALUE SCIENCE – I	CF	1	0	2	2.0
		TOTAL		16	2	8	21.0

SEMESTER-II

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT201	LINEAR ALGEBRA	CP	3	1	0	3.5
2	UCT202	STATISTICAL MODELING	CP	3	0	2	4.0
3	UCT203	DATA STRUCTURES & ALGORITHMS	CP	3	0	2	4.0
4	UEC002	PRINCIPLES OF ELECTRONICS	CF	3	0	2	4.0
5	UHU007	FUNDAMENTALS OF ECONOMICS	CF	2	0	0	2.0
6	UHU012	BUSINESS COMMUNICATION & VALUE SCIENCE –II	CF	1	0	2	2.0
7	UEN003	ENVIRONMENTAL STUDIES	CF	2	0	0	2.0
		TOTAL		17	1	8	21.5
4 Weeks – Exchange Program among the Participating Institutes							

SEMESTER-III

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT301	FORMAL LANGUAGE AND AUTOMATA THEORY	CP	3	1	0	3.5
2	UCT302	COMPUTER ORGANIZATION & ARCHITECTURE	CP	3	0	2	4.0
3	UCT303	OBJECT ORIENTED PROGRAMMING	CP	3	0	2	4.0
4	UCT304	COMPUTATIONAL STATISTICS	CP	3	1	2	4.5
5	UCT305	SOFTWARE ENGINEERING	CP	3	0	2	4.0
6		INDIAN CONSTITUTION (Non-Credit)					
		TOTAL		15	1	8	20

SEMESTER-IV

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT401	OPERATING SYSTEMS	CP	3	0	2	4.0
2	UCT402	DATABASE MANAGEMENT SYSTEMS	CP	3	0	2	4.0
3	UCT403	SOFTWARE DESIGN WITH UML	CP	2	0	2	3.0
4	UHU023	INTRODUCTION TO INNOVATION, IP MANAGEMENT AND ENTREPRENEURSHIP	CF	3	0	0	3.0
5	UHU024	DESIGN THINKING	CF	2	0	2	3.0
6	UMA019	OPERATIONS RESEARCH	CF	3	0	2	4.0
7	UHU025	MARKETING RESEARCH & MARKETING MANAGEMENT	CF	2	0	0	2.0
8		ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE (Non-Credit)					
		TOTAL		18	0	10	23.0
4 Weeks – Exchange Program among the Participating Institutes							

SEMESTER-V

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT501	DESIGN AND ANALYSIS OF ALGORITHMS	CP	3	0	2	4.0
2	UCT502	COMPILER DESIGN	CP	3	0	2	4.0
3	UHU029	FUNDAMENTALS OF MANAGEMENT	CF	2	0	0	2.0
4	UHU030	BUSINESS STRATEGY	CF	2	0	0	2.0
5	UHU042	BUSINESS COMMUNICATION & VALUE SCIENCE-III	CF	1	0	2	2.0
6		ELECTIVE II	PE	3	0	2	4.0
7		ELECTIVE I	PE	2	1	2	3.5
8	UCT591	MINI PROJECT	PR	-	-	-	1.0
		TOTAL		16	1	10	22.5

SEMESTER-VI

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT601	COMPUTER NETWORKS	CP	3	0	2	4.0
2	UCT602	INFORMATION SECURITY	CP	3	0	2	4.0
3	UCT603	ARTIFICIAL INTELLIGENCE	CP	3	0	2	4.0
4	UHU043	FINANCIAL & COST ACCOUNTING	CF	2	0	0	2.0
5	UHU044	BUSINESS COMMUNICATION & VALUE SCIENCE-IV	CF	2	0	2	3.0
6		ELECTIVE III	PE	3	0	2	4.0
7		ELECTIVE I V	PE	2	0	2	3.0
		TOTAL		18	0	12	24.0
Industrial Project (6-8 weeks)							

SEMESTER-VII

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT701	USABILITY DESIGN OF SOFTWARE APPLICATIONS	CP	2	0	2	3.0
2	UCT702	IT WORKSHOP SKYLAB/MATLAB	CP	1	0	2	2.0
3	UHU047	FINANCIAL MANAGEMENT	CF	2	1	0	2.5
4	UHU048	HUMAN RESOURCE MANAGEMENT	CF	2	0	2	3.0
5		ELECTIVE V	PE	2	1	2	3.5
6		ELECTIVE VI	PE	2	0	2	3.0
7	UHU049	SERVICES SCIENCE & SERVICE OPERATIONAL MANAGEMENT	CP	3	0	2	4.0
8	UCT703	IT PROJECT MANAGEMENT	CP	3	0	2	4.0
		TOTAL		17	2	14	25.0

SEMESTER-VIII

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT891	PROJECT SEMESTER	PR	-	-	-	15
OR							
1	UCT802	SOCIAL NETWORK ANALYSIS	CP	2	0	2	3
2	UCT801	ETHICAL HACKING	CP	3	0	2	4
3	UCT898	CAPSTONE PROJECT	PR	-	-	-	8
OR							
1	UCT894	START UP SEMSTER*	PR	-	-	-	15
		TOTAL		-	-	-	15

* Based on Hands on Work on Innovations and Entrepreneurship

ELECTIVE I

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT511	CONVERSATIONAL SYSTEMS	PE	2	1	2	3.5

2	UCT512	CLOUD, MICROSERVICES AND APPLICATION	PE	2	1	2	3.5
3	UCT513	MACHINE LEARNING	PE	2	1	2	3.5

ELECTIVE II

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UHU026	BEHAVIOURAL ECONOMICS	PE	3	0	2	4.0
2	UHU027	COMPUTATIONAL FINANCE & MODELING	PE	3	0	2	4.0
3	UHU028	INDUSTRIAL PSYCHOLOGY	PE	3	0	2	4.0

ELECTIVE III

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT631	ROBOTICS AND EMBEDDED SYSTEMS	PE	3	0	2	4.0
2	UCT632	MODERN WEB APPLICATIONS	PE	3	0	2	4.0
3	UCT633	DATA MINING & ANALYTICS	PE	3	0	2	4.0

ELECTIVE IV

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT642	ENTERPRISE SYSTEMS	PE	2	0	2	3.0
2	UHU046	ADVANCE FINANCE	PE	2	0	2	3.0
3	UCT641	IMAGE RECOGNITION AND PATTERN RECOGNITION	PE	2	0	2	3.0

ELECTIVE V

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT721	COGNITIVE SCIENCE & ANALYTICS	PE	2	1	2	3.5
2	UCT722	INTRODUCTION TO IOT	PE	2	1	2	3.5
3	UCT723	CRYPTOLOGY	PE	2	1	2	3.5

ELECTIVE VI

S. N.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCT731	QUANTUM COMPUTATION & QUATUM INFORMATION	PE	2	0	2	3.0
2	UCT732	ADVANCED SOCIAL, TEXT AND MEDIA ANALYTICS	PE	2	0	2	3.0
3	UCT733	MOBILE COMPUTING	PE	2	0	2	3.0

Nature of Course	CODE
Core-Foundation Courses	CF
Core-Professional Courses	CP
Generic Electives	GE
Professional Electives	PE
Project Based Courses	PR

SEMESTER WISE CREDITS FOR BE: COMPUTER SCIENCE & BUSINESS SYSTEMS

Nature of Course	Credits to be Earned (As per Choice Based Credit System)								
	Semesters								Total
	I	II	III	IV	V	VI	VII	VIII	
Core-Foundation Courses	10.5	10	0	12	6	5	9.5	0	53.0
Core-Professional Courses	10.5	11.5	20	11	8	12	9.0	7	89.0
Professional & Generic Electives	0	0	0	0	7.5	7	6.5	0	21.0
Project Based Courses	0	0	0	0	1	0	0	8	9.0
								Total	**172.0**

UCT101: DISCRETE MATHEMATICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: Detailed study of various discrete and algebraic structures, basic logic, basics of counting and proof techniques.

Boolean algebra: Introduction of Boolean algebra, truth table, basic logic gate, basic postulates of Boolean algebra, principle of duality, canonical form, Karnaugh map. Abstract algebra: Set, relation, group, ring, field.

Combinatorics: Basic counting, balls and bins problems, generating functions, recurrence relations. Proof techniques, principle of mathematical induction, pigeonhole principle.

Graph Theory: Graphs and digraphs, complement, isomorphism, connectedness and reachability, adjacency matrix, Eulerian paths and circuits in graphs and digraphs, Hamiltonian paths and circuits in graphs and tournaments, trees; Planar graphs, Euler‟s formula, dual of a planer graph, independence number and clique number, chromatic number, statement of Four-color theorem.

Logic: Propositional calculus - propositions and connectives, syntax; Semantics - truth assignments and truth tables, validity and satisfiability, tautology; Adequate set of connectives; Equivalence and normal forms; Compactness and resolution; Formal reducibility - natural deduction system and axiom system; Soundness and completeness.

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

The students will be able to reflect on:

1. Perform operations on various discrete structures such as set, function and relation.
2. Evaluate Boolean functions and simplify expression using the properties of Boolean algebra.
3. Illustrate the basic properties and algorithms of graphs and apply them in modeling and solving real-world problems.
4. Comprehend formal logical arguments and translate statements from a natural language into its symbolic structures in logic.
5. Identify and prove various properties of rings, fields and group.

Text Books:

1. Rosen H. K., Discrete Mathematics and its Applications, McGraw Hill (2011) 7thed.
2. Tremblay P. J. and Manohar, R., Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill (2008).
3. Topics in Algebra, I. N. Herstein, John Wiley and Sons.
4. Digital Logic & Computer Design, M. Morris Mano, Pearson.
5. Elements of Discrete Mathematics, (Second Edition) C. L. LiuMcGraw Hill, New Delhi.
6. Graph Theory with Applications, J. A. Bondy and U. S. R. Murty, Macmillan Press, London.
7. Mathematical Logic for Computer Science, L. Zhongwan, World Scientific, Singapore.

Reference Books:

1. Gallian A. J., Contemporary Abstract Algebra, Cengage Learning (2017) 9th ed.
2. Lipschutz S., Lipson M., Discrete Mathematics, McGraw-Hill (2007) 3rded.
3. Introduction to linear algebra. Gilbert Strang.
4. Introductory Combinatorics, R. A. Brualdi, North-Holland, New York.
5. Graph Theory with Applications to Engineering and Computer Science, N. Deo, Prentice Hall, Englewood Cliffs.
6. Introduction to Mathematical Logic, (Second Edition), E. Mendelsohn, Van-Nostrand, London.

UCT102: PROBABILITY AND STATISTICS

L	T	P	Cr
3	0	0	3.0

Course Objectives: This course shall make the students familiar with the concepts of Probability and Statistics useful in implementing various computer science models. One will also be able to associate distributions with real-life variables and make decisions based on statistical methods.

Introduction to Statistics: Definition of Statistics. Basic objectives. Applications in various branches of science with examples. Collection of Data: Internal and external data, Primary and secondary Data. Population and sample, Representative sample. Descriptive Statistics: Classification and tabulation of univariate data, graphical representation, Frequency curves. Descriptive measures - central tendency and dispersion. Bivariate data. Summarization, marginal and conditional frequency distribution.

Probability: Concept of experiments, sample space, event. Definition of Combinatorial Probability. Conditional Probability, Bayes Theorem. Probability distributions: discrete& continuous distributions, Binomial, Poisson and Geometric distributions, Uniform, Exponential, Normal, Chi-square, t, F distributions. Expected values and moments: mathematical expectation and its properties, Moments (including variance) and their properties, interpretation, Moment generating function.

Calculus: Basic concepts of Differential and integral calculus, application of double and triple integral.

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

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

1. Analyze the data using different descriptive measures and present graphically.
2. Compute the probabilities of events along with an understanding of the random variables, expectation, variance and distributions.
3. Understand the estimation of mean and variance and their respective one-sample and k-sample hypothesis tests.
4. Understand the law of large numbers and the central limit theorem and how these concepts are used to model various random phenomena.

Text Books:

1. Introduction of Probability Models, S.M. Ross, Academic Press, N.Y.
2. Fundamentals of Statistics, vol. I & II, A. Goon, M. Gupta and B. Dasgupta, World Press.
3. Higher Engineering Mathematics, B. S. Grewal, Khanna Publication, Delhi.

Reference Books:

1. A first course in Probability, S.M. Ross, Prentice Hall.
2. Probability and Statistics for Engineers, (Fourth Edition), I.R. Miller, J.E. Freund and R. Johnson, PHI.

3. Introduction to the Theory of Statistics, A.M. Mood, F.A. Graybilland D.C. Boes, McGraw Hill Education.
4. Advanced Engineering Mathematics, (Seventh Edition), Peter V. O'Neil, Thomson Learning.
5. Advanced Engineering Mathematics, (Second Edition) M. D. Greenberg, Pearson Education.
6. Applied Mathematics, Vol. I & II, P. N. Wartikar and J. N. Wartikar,Vidyarthi Prakashan.

UCT104: FUNDAMENTAL OF COMPUTER SCIENCE

L	T	P	Cr
3	0	2	4.0

Course Objectives: This course is designed to explore computing and to show students the art of computer programming. Students will learn some of the design principles for writing good programs.

General problem Solving concepts: Algorithm, and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops.

Imperative languages: Introduction to imperative language; syntax and constructs of a specific language (ANSI C)

Types Operator and Expressions with discussion of variable naming and Hungarian Notation: Variable Names, Data Type and Sizes (Little Endian Big Endian), Constants, Declarations, Arithmetic Operators, Relational Operators, Logical Operators, Type Conversion, Increment Decrement Operators, Bitwise Operators, Assignment Operators and Expressions, Precedence and Order of Evaluation, proper variable naming and Hungarian Notation.

Control Flow with discussion on structured and unstructured programming: Statements and Blocks, If-Else-If, Switch, Loops – while, do, for, break and continue, goto labels, structured and un- structured programming.

Functions and Program Structure with discussion on standard library: Basics of functions, parameter passing and returning type, C main return as integer, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialization, Recursion, Pre-processor, Standard Library Functions and return types.

Pointers and Arrays: Pointers and address, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Multi-dimensional array and Row/column major formats, Initialization of Pointer Arrays, Command line arguments, Pointer to functions, complicated declarations and how they are evaluated.

Structures: Basic Structures, Structures and Functions, Array of structures, Pointer of structures, Self-referral structures, Table look up, typedef, unions, Bit-fields

Input and Output: Standard I/O, Formatted Output – printf, Formated Input – scanf, Variable length argument list, file access including FILE structure, fopen, stdin, sdtout and stderr, Error Handling including exit, perror and error.h, Line I/O, related miscellaneous functions.

Unix system Interface: File Descriptor, Low level I/O – read and write, open, create, close and unlink, Random access – lseek, Discussions on Listing Directory, Storage allocator.

Programming Method: Debugging, Macro, User Defined Header, User Defined Library Function, makefile utility.

Laboratory Work:

1. Algorithm and flowcharts of small problems like GCD
2. Structured code writing with:
    i. Small but tricky codes
    ii. Proper parameter passing
    iii. Command line Arguments
    iv. Variable parameter
    v. Pointer to functions
    vi. User defined header
    vii. Make file utility
    viii. Multi file program and user defined libraries
    ix. Interesting substring matching / searching programs
    x. Parsing related assignments

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

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

1. Comprehend concepts related to computer hardware and software, draw flowcharts and write algorithm/ pseudo code.
2. Write, compile and debug programs in C language, using different data types, operators, decision control statements, loop control statements, case control structures, and functions.
3. Design programs involving the concept of arrays, structure, strings and pointers construct.
4. Comprehend the concept of UNIX system interface by using the system call for file handling.

Text Books:

1. The C Programming Language, (Second Edition) B. W. Kernighan and D. M. Ritchi, PHI.
2. Programming in C, (Second Edition) B. Gottfried, Schaum Outline Series.

Reference Books:

1. C: The Complete Reference, (Fourth Edition), Herbert Schildt, McGraw Hill.
2. Let Us C, Yashavant Kanetkar, BPB Publications.

UEE002: PRINCIPLES OF ELECTRICAL ENGINEERING

L	T	P	Cr
3	0	2	4.0

Course Objectives: To introduce concepts of DC and AC circuits and electromagnetism. To make the students understand the concepts and working of single-phase transformers, DC motor and generators.

Introduction: Fundamental linear passive and active elements to their functional current-voltage relation, voltage source and current sources, ideal and practical sources, Kirchhoff-s laws and applications to network solutions using mesh and nodal analysis, Concept of work, power, energy, and conversion of energy.

Basic network: Current-voltage relations of the electric network by mathematical equations to analyze the network (Thevenin‟s theorem, Norton's Theorem, Maximum Power Transfer theorem) Simplifications of networks using series-parallel, Star/Delta transformation. Superposition theorem.

Concept of AC: AC waveform definitions, form factor, peak factor, phasor representation in polar and rectangular form, concept of impedance, admittance, complex power, power factor, single phase and three phase concept.

Electrostatics and Electro-Mechanics: Electrostatic field, electric field strength, concept of permittivity in dielectrics, energy stored in capacitors, charging and discharging of capacitors. ElectroMagnetism, magnetic field and Faraday's law. Magnetic materials and B-H curve. Self and mutual inductance, Ampere's law, Study of R-L, R-C, RLC series circuit, R-L-C parallel circuit. Electromechanical energy conversion.

Measurements and Sensors: Measuring devices/sensors and transducers (Piezoelectric and thermo-couple) related to electrical signals, Elementary methods for the measurement of electrical quantities in DC and AC systems (Current & Single-phase power). Concept of indicating and integrating instruments.

Practical considerations: Electrical Wiring types and accessories, Illumination system, Basic layout of the distribution system, Types of earthing, Safety devices & systems. Battery principles and types.

Laboratory

1. Familiarization of electrical circuits: sources, measuring devices and transducers
2. Determination of resistance temperature coefficient
3. Verification of Network Theorem (Superposition, Thevenin, Norton, Maximum Power
4. Transfer theorem)
5. Simulation of R-L-C series circuits for XL>XC , XL< XC
6. Simulation of Time response of RC circuit
7. Demonstration of measurement of electrical quantities in DC and AC systems.

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

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

1. To apply basic concepts, network laws and theorems to solve DC circuits.
2. Signify AC quantities through phasor and compute single-phase series and parallel AC system behavior during steady state.
3. Elucidate the need of three phase system, calculations and power measurement in three-phase system.
4. Comprehend and apply the basic concepts of Electro-statics and Electro-mechanics.
5. Elucidate the principles of various measurement systems.
6. Elucidate the practical considerations of wiring systems.

Text Books:

1. Electric Machinery, (Sixth Edition) A. E. Fitzgerald, Kingsely Jr Charles, D. Umans Stephen, Tata McGraw Hill, 2003.
2. A Textbook of Electrical Technology, (vol. I), B. L. Theraja, Chand and Company Ltd., New Delhi, 2002.
3. Basic Electrical Engineering, V. K. Mehta, S. Chand and Company Ltd., New Delhi, 2012.
4. Theory and problems of Basic Electrical Engineering, (Second Edition), J. Nagrath and Kothari, Prentice Hall of India Pvt. Ltd, 1998.

Reference Books:

1. Basic Electrical Engineering, T. K. Nagsarkar and M. S. Sukhija, Oxford University Press, 2011.
2. Introduction to Electrodynamics, D. J. Griffiths, (Fourth Edition), Cambridge University Press, 2005.
3. Engineering Circuit Analysis, William H. Hayt& Jack E. Kemmerly, McGraw-Hill Book Company Inc, 1978.
4. Fundamentals of Electrical and Electronics Engineering, Smarajit Ghosh, Prentice Hall (India) Pvt. Ltd, 2007.

UPH014: PHYSICS FOR COMPUTING SCIENCE

L	T	P	Cr
3	1	2	4.5

Course Objectives: To introduce the student to the basic physical laws of oscillators, electromagnetic waves, wave optics, lasers, solid-state physics, thermodynamics etc. and demonstrate their applications in technology. To introduce the student to measurement principles and their application to investigate physical phenomena.

Oscillation: Periodic motion-simple harmonic motion-characteristics of simple harmonic motion-vibration of simple spring mass system. Resonance-definition., damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators.

Interference-principle of superposition-young's experiment: Theory of interference fringes-types of interference-Fresnel‟s prism-Newton‟s rings, Diffraction-Two kinds of diffraction-Difference between interference and diffraction-Fresnel‟s half period zone and zone plate-Fraunhofer diffraction at single slit-plane diffraction grating. Temporal and Spatial Coherence.

Polarization of light: Polarization - Concept of production of polarized beam of light from two SHM acting at right angle; plane, elliptical and circularly polarized light, Brewster‟s law, double refraction.

Basic Idea of Electromagnetisms: Continuity equation for current densities, Maxwell‟s equation in vacuum and non-conducting medium.

Semiconductor Physics: Conductor, Semiconductor and Insulator; Basic concept of Band theory.

Laser and Fiber optics: Einstein‟s theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: Ruby Laser, CO2 and Neodymium lasers; Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in engineering. Fiber optics and Applications, Types of optical fibers.

Thermodynamics: Zeroth law of thermodynamics, first law of thermodynamics, brief discussion on application of 1st law, second law of thermodynamics and concept of Engine, entropy, change in entropy in reversible and irreversible processes.

Laboratory Work:

1. Magnetic field along the axis of current carrying coil – Stewart and Gee
2. Determination of Hall coefficient of semi-conductor
3. Determination of Plank constant
4. Determination of wave length of light by Laser diffraction method
5. Determination of wave length of light by Newton‟s Ring method
6. Determination of laser and optical fiber parameters
7. Determination of Stefan‟s Constant.

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

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

1. Understand the concepts of waves and oscillations and their properties in mechanical and electrical components.
2. Demonstrate interference, diffraction and polarization of light.
3. Explain the working principle of Lasers.
4. Explain the working of an Engine and how entropy is related to the evolution of thermodynamic processes
5. Perform an experiment, collect data, tabulate and report them, and interpret the results with error analysis.

Text Books:

1. Concepts of Modern Physics, (Fifth Edition) A Beiser, McGraw Hill International.
2. Fundamentals of Physics, David Halliday, Robert Resnick and Jearl Walker, Wileyplus, 10th Edition (2015)

Reference Books:

1. Optics, (Fifth Edition) AjoyGhatak, Tata McGraw Hill.
2. Sears & Zemansky University Physics, Addison-Wesley.
3. Fundamentals of Optics, (Third Edition) Jenkins and White, McGraw-Hill.

UHU011: BUSINESS COMMUNICATION & VALUE SCIENCE - I

L	T	P	Cr
1	0	2	2.0

Course Objectives: Understand what life skills are and their importance in leading a happy and well-adjusted life. Motivate students to look within and create a better version of self. Introduce them to key concepts of values, life skills and business communication.

- **Overview of the course with immersion activity**
- **Overview of biz communication**
- **Self-awareness, confidence and communication**
- **Essentials of Business communication**
- **Application of communication skills**
- **Application of Life Skills**
- **Assignment**

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

Upon completion of this course, the students will be able to

1. Recognize the need for life skills and values
2. Recognize own strengths and opportunities
3. Apply the life skills to different situations
4. Understand the basic tenets of communication
5. Apply the basic communication practices in different types of communication.

Text Books:

There are no prescribed texts for Semester 1 – there will be handouts and reference links shared.

Reference Books:

1. English vocabulary in use – Alan Mc‟carthy and O‟dell
2. APAART: Speak Well 1 (English language and communication)
3. APAART: Speak Well 2 (Soft Skills)
4. Business Communication – Dr. SarojHiremath

UCT201: LINEAR ALGEBRA

L	T	P	Cr
3	1	0	3.5

Course Objectives: The Linear algebra course provide the in-depth knowledge about the mathematical formulation building for real world problems in engineering and technology. Students will be able to learn the vector space and linear combination, orthogonality and projections, spanning of vector space and their fundamental relationship with computer science.

Introduction to Matrices and Determinants: Solution of Linear Equations; Cramer's rule; Inverse matrix.

Vectors and linear combinations: Rank of a matrix; Gaussian elimination; LU decomposition; Solving systems of linear equations using the tools of matrices.

Vector space; Dimension; Basis: Orthogonality; Projections; Gram-Schmidt orthogonalization and QR decomposition.

Eigenvalues and Eigenvectors: Positive definite matrices; Linear transformations; Hermitian and unitary matrices.

Singular value decomposition and Principal component analysis: Introduction to their applications in Image Processing and Machine Learning.

Course Learning Outcomes (CLOs)/ Course Objectives (COs):
The students will be able to:

1. Apply basic concept for the solution of a linear system, AX=B and find all solutions by choosing an effective method such as Cramer's rule; Inverse matrix and Gaussian elimination.
2. Learn about the vector space and linear combination, orthogonality and projections, spanning of vector space and their fundamental relationship with computer science.
3. Find the Gram-Schmidt orthogonalization of a matrix; QR decomposition, determine the rank, determinant, eigenvalues and eigenvectors, diagonalization, and different factorizations of a matrix.
4. Identify special properties of a matrix, such as symmetric of Hermitian, positive definite, etc., and use this information to facilitate the calculation of matrix characteristics.
5. Use the singular value decomposition and principal component analysis in the practical applications like medical image denoising and machine learning.

Text Books:

1. Seymour Lipschutz, Schaum's Outline of Linear Algebra, McGraw Hill Education, 3rd edition, 2017.
2. Gilbert Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press, 5th Edition, 2016.

Reference Books:

1. David C. Lay, Steven R. Lay, Judi J. Mcdonald, Linear Algebra and Its Applications Loose Leaf, Pearson College Div, 5th edition, 2015.
2. Kuldeep Singh, Linear Algebra: Step by Step, Oxford University Press, 1st Edition, 2013.

UCT202: STATISTICAL MODELING

L	T	P	Cr
3	0	2	4.0

Course Objectives: To provide an understanding of various statistical methods such as correlation analysis, regression, sampling, estimation, non-parametric inference, time-series analysis and forecasting.

Sampling Techniques: Random sampling, Sampling from finite and infinite populations, Estimates and standard error (sampling with replacement and sampling without replacement), Sampling distribution of sample mean, stratified random sampling.

Linear Statistical Models: Scatter diagram. Linear regression and correlation, least squares method, Rank correlation, Multiple regression & multiple correlation, Analysis of variance (one way, two way with as well as without interaction).

Estimation: Point estimation, criteria for good estimates (un-biasedness, consistency), Methods of estimation including maximum likelihood estimation.

Sufficient Statistic: Concept & examples, complete sufficiency, their application in estimation.

Test of hypothesis: Concept & formulation, Type I and Type II errors, Neyman Pearson lemma, Procedures of testing.

Non-parametric Inference: Comparison with parametric inference, Use of order statistics, Sign test, Wilcoxon signed rank test, Mann-Whitney test, Run test, Kolmogorov-Smirnov test, Spearman‟s and Kendall‟s test, Tolerance region.

Basics of Time Series Analysis & Forecasting: Stationary, ARIMA Models: Identification, Estimation and Forecasting.

Laboratory Work:

R statistical programming language: Introduction to R, Functions, Control flow and Loops, working with Vectors and Matrices, reading in Data, writing Data, working with Data, Manipulating Data, Simulation, Linear model, Data Frame, Graphics in R

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

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

1. Comprehend different sampling techniques for designing and selecting a sample from a population.
2. Apply and interpret basic modeling techniques for bivariate data and use inferential methods in the context of simple linear models.
3. Understand the estimation of finite population parameters e.g. mean and variance including maximum likelihood estimation.

4. Comprehend the basics of hypothesis testing and perform different non-parametric tests.
5. Illustrate and apply the important features to describe a time series and perform simple analysis and computations on series.

Text Books:

1. Miller I.R., Freund J.E. and Johnson R., Probability and Statistics for Engineers, Pearson Education India (2015) 8th ed.
2. Goon A.M., Gupta M.K. and Dasgupta B., Fundamentals of Statistics, Vol. I & II, The World Press (2002), 8th ed.
3. Chatfield C., The Analysis of Time Series: An Introduction, Chapman & Hall/CRC (2003) 6th ed.

Reference Books:

1. Montgomery D.C. and Peck E., Introduction to Linear Regression Analysis, Wiley-Interscience (2006), 4th ed.
2. Mood A.M., Graybill F.A. and Boes D.C. Introduction to the Theory of Statistics, McGraw Hill (2017), 4th ed.
3. Draper N. and Smith H., Applied Regression Analysis, Wiley-Interscience (1998), 3rd ed.
4. Grolemund G., Hands-on Programming with R, O′Reilly (2014).
5. Lander J.P., R for Everyone: Advanced Analytics and Graphics, Addison-Wesley Professional (2017), 2nd ed.

UCT203: DATA STRUCTURES AND ALGORITHMS

L	T	P	Cr
3	0	2	4.0

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

Basic Terminologies and Introduction to Algorithm & Data Organization: Algorithm specification, Recursion, Performance analysis, Asymptotic Notation - The Big-O, Omega and Theta notation, Refinement of Coding - Time-Space Trade Off, Testing, Data Abstraction

Linear Data Structure: Array, Stack, Queue, Linked-list and its types, Various Representations, Operations & Applications of Linear Data Structures

Non-linear Data Structure: Binary Tree, Binary Search Tree, Balancing of Search Trees – AVL Trees, Operations & Applications of Non-Linear Data Structures

Searching and Sorting on Various Data Structures: Divide-and-Conquer – Review, Linear Search, Binary Search, Insertion Sort, Merge Sort, Quick Sort, Heapsort, Radix sort, bucket sort, Introduction to Hashing

Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

Laboratory work:
Implementation of Arrays, Recursion, Stacks, Queues, Lists, trees, graphs, Sorting techniques, Searching techniques.

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

1. Apply basic concepts of asymptotic notation in analysis of algorithm.
2. Understand and implement various linear data structures: Arrays, Stack, Queue and Link list.
3. Implement various searching and sorting techniques based on characteristics of application.
4. Understand and Implement various Non linear data structures: Trees and Graphs.

Text Books:

1. Introduction to Algorithms, Thomas, H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, The MIT Press.
2. Fundamentals of Data Structures, E. Horowitz, S. Sahni, S. A-Freed, Universities Press.
3. Data Structures and Algorithms, A. V. Aho, J. E. Hopperoft, J. D. UIlman, Pearson.

Reference books:

1. The Art of Computer Programming: Volume 1: Fundamental Algorithms, Donald E. Knuth.
2. Open Data Structures: An Introduction (Open Paths to Enriched Learning), (Thirty First Edition), Pat Morin, UBC Press.
3. Micheal T. Goodrich and Roberto Tamassia: Algorithm Design: Foundations, Analysis and Internet examples (John Wiley &Sons, Inc., 2002).

UEC002: PRINCIPLES OF ELECTRONICS

L	T	P	Cr
3	0	2	4.0

Course Objectives: To enhance comprehension capabilities of students through understanding of electronic devices, various logic gates, SOP, POS and their minimization techniques, various logic families and information on different IC‟s and working of combinational circuits and their applications.

Introductory idea of semiconductors: Formation of P-N junction, energy band diagram, built-in-potential, forward and reverse biased P-N junction, formation of depletion zone. Formation of PNP / NPN junctions, energy band diagram.

Diodes and Diode Circuits: V-I characteristics, Zener breakdown, Avalanche breakdown and its reverse characteristics; Junction capacitance and Varactor diode. Simple diode circuits, load line, linear piecewise model; Rectifier circuits: half wave, full wave, PIV, DC voltage and current, ripple factor, efficiency, idea of regulation.

Transistors and transistor circuits: Transistor mechanism and principle of transistors, CE, CB, CC configuration, transistor characteristics: cut-off active and saturation mode Concept of Field Effect Transistors (channel width modulation), Gate isolation types, JFET Structure and characteristics, MOSFET Structure and characteristics, depletion and enhancement type; CS, CG, CD configurations; CMOS: Basic Principles.

Operational amplifier basics: Introduction to integrated circuits, operational amplifier and its terminal properties; Application of operational amplifier; inverting and non-inverting mode of operation, Proportional, Integral, Derivative circuits.

Basic ideas of Digital electronics: Basic idea of switching circuit, Realization of Logic gates, multiplexers and demultiplexers, Flip flop, Registers and Counters.

Laboratory Work:

1. Familiarization with CRO, DSO, electronic components(Resistor, capacitor, inductor, LED, seven segment display, diodes, transistor, logic gates, integrated circuits)

2. Experiments cover studying VI characteristics of pn and zener diode, half wave and full wave rectifier, design clipper circuits, switching characteristics of BJT
3. Verification of De-Morgan laws, logic gates; implementation of Boolean functions, Half Adder, Full Adder using Multiplexers and Encoders.
4. To study and analyze the working of inverting and non-inverting amplifier, amplifier as summer and average circuits.
5. Simulation of above analog and digital circuits using Multisim software

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

The student will be able to:

1. Demonstrate the use of semiconductor diodes in various applications.
2. Discuss and explain the working of transistors, their configurations and applications.
3. Design and implement combinational and sequential circuits.
4. Reduce Boolean expressions and implement them using Logic ICs.
5. Discuss and analyze the concept, working and applications of FETs, Operational Amplifiers and Oscillators.

Text Books:

1. Adel S. Sedra and Kenneth Carless Smith, Microelectronics Circuits, Oxford University Press.
2. Jacob Millman, Christos Halkias, Chetan Parikh, Millman‟s Integrated Electronics, McGraw Hill Education.

Reference Books:

1. Robert L. Boylestad, Louis Nashelsky, Electronic Devices & Circuit Theory 11th ed.
2. D Schilling C Belove T Apelewicz R Saccardi, Electronics Circuits: Discrete & Integrated.

UHU007: FUNDAMENTALS OF ECONOMICS

L	T	P	Cr
2	0	0	2.0

Course Objectives: The purpose of the course is to enable the students to learn and apply economics concepts to assist in decision making to achieve desired economic goals. The course will help acquire knowledge of various market structures and learn how they function. This course will help to enhance their capability to comprehend the prevailing economic and business policy.

Microeconomics: Principles of Demand and Supply - Supply Curves of Firms - Elasticity of Supply; Demand Curves of Households - Elasticity of Demand; Equilibrium and comparative Statics (Shift of a Curve and Movement along the Curve); Welfare Analysis - Consumers‟ and Producers‟ Surplus - Price Ceilings and Price Floors; Consumer Behaviour - Axioms of Choice - Budget Constraints and Indifference Curves; Consumer‟s Equilibrium - Effects of a Price Change, Income and Substitution Effects -Derivation of a Demand Curve; Applications - Tax and Subsidies - Intertemporal Consumption - Suppliers‟ Income Effect; Theory of Production – Production Function and Iso-quants - Cost Minimization; Cost Curves - Total, Average and Marginal Costs -Long Run and Short Run Costs; Equilibrium of a Firm Under Perfect Competition; Monopoly and Monopolistic Competition

Macroeconomics: National Income and its Components - GNP, NNP, GDP, NDP; consumption Function; Investment; Simple Keynesian Model of Income Determination and the Keynesian Multiplier; Government Sector - Taxes and Subsidies; External Sector - Exports and Imports; Money - Definitions; Demand for Money -Transactionary and Speculative Demand; Supply of Money - Bank‟s Credit Creation Multiplier; Integrating Money and Commodity Markets - IS, LM Model; Business Cycles and Stabilization - Monetary and Fiscal Policy - Central Bank and the Government; The Classical Paradigm - Price and Wage Rigidities - Voluntary and Involuntary Unemployment

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

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

1. Deduce reasonable predictions about possible economic outcomes based upon economic conditions and economic theories.
2. Analyze data to support economic decision making using statistical and econometric techniques.
3. Evaluate alternative economic policies.
4. Create explanations for new economic phenomena and device innovative approaches to solve various economic problems.

Text Books:

1. Pindyck, Robert S., and Daniel L. Rubinfeld, Microeconomics, Pearson; 2017.
2. Dornbusch, Fischer and Startz. Macroeconomics, McGraw Hill Education;, 2018
3. Paul Anthony Samuelson, William D. Nordhaus. Economics, McGraw-Hill, 2019

Reference Books:

1. Intermediate Microeconomics: A Modern Approach, Hal R, Varian, SPRINGER, 2019.
2. Principles of Macroeconomics, N. Gregory Mankiw, Cengage Learning India Pvt. Ltd, 2017.

UHU012: BUSINESS COMMUNICATION & VALUE SCIENCE – II

L	T	P	Cr
1	0	2	2.0

Course Objectives: Students will learn the basic concepts of speed reading like scanning and skimming. They will learn to create communication material with Lucid writing techniques and will learn the concepts to recognize the outward and internal behavior.

Ice breaker.

1) Participate in „Join Hands Movement". Individual identification of social issues.
2) Each Individual chooses one particular social issue which they would like to address.
3) Class to be divided in teams for the entire semester. All activities to be done in teams and the grades, credit points will be captured in the leader board in the class room.
4) Theory to introduce the participant Slam book to be used for capturing individual learning points and observations.

Research on the social cause each group will work for.

5) Class discussion- Good and Bad Writing. Common errors, punctuation rules, use of words.
6) Group Practical – As a group, they will work on the social issue identified by them. Research, read and generate a report based on the findings. (Apply the learning and recap from the session)
7) Practical: Plan and design an E Magazine. Apply and assimilate the knowledge gathered from Sem-1 till date. Share objective & guideline. All members to contribute an article to the magazine, trainer to evaluate the content.
8) Lucid Writing: Encourage the students to go through the links given about Catherine Morris and Joanie Mcmahon"s writing techniques.
9) Create the magazine
10) SATORI – Participants share the personal take away acquired from GD, writing and reading skills activities captured in their handbook. Share the most important learning points from the activities done so far and how that learning has brought a change.
11) Launching an E Magazine.
12) Each group will form an NGO. Create Vision, Mission, Value statement, tagline and Design a logo.
13) Introduction to basic presentation skills & ORAI app
14) Groups to present their NGOs. Apply the learning gathered from session 2. Presentation to be recorded by the groups. feedback from the audience/ Professor
15) Group to come back and share their findings from the recording. Post work- individual write up to be written and evaluated for the E- magazine
16) Prepare and publish the Second episode of the E Magazine.
17) Speed Reading session: Introduction to skimming and scanning; practice the same.
18) SATORI – Join the dots- Participants to connect their learning gathered from AIP
19) Ad campaign- Brain storming session- Students to discuss and explore the means of articulating and amplifying the social issue their NGOs are working for.
20) Design a skit- a) write the script articulating the message of their respective NGOs. Read out the script. (Skit time-5 minutes). Feedback of Theory.

Promote the play through a social media and gather your audience. Enact the play. Capture the numbers of likes and reviews. Theory to assign grades to individual team.

(1) Theory to find out from the participants their views, observations and experiences of working in a team(2) Intro of Dr. Meredith Belbin and his research on team work and how individuals contribute.

Cont. (3) Belbin's 8 Team Roles and Lindgren's Big 5 personality traits.(4) Belbin's 8 team player styles

21) (1) Team Falcon Practical to identify individual personality traits with Belbin's 8 team player styles (2) Similar personality types to form groups (3) Groups present their traits.
22) Prepare and publish the third episode of the E Magazine. SATORI – (join the dots with participants personal life) Participants share the personal take away acquired from working in teams, GD, learning about presentations, presenting their NGOs
23) Ten minutes of your time – a short film on diversity. Play the video (link to be attached in the FG)
24) Session on Diversity & Inclusion- Different forms of Diversity in our society.
25) Debate on the topic of diversity with an angle of ethics, morality and respect for individual (In the presence of an external moderator). Groups will be graded by the professor.
26) (Project- 1) Each team to look for an NGO/ social group in the city which is working on the issue their college group is supporting.
27) Spend a day with the NGO/ social group to understand exactly how they work and the challenges they face.
28) Render voluntary service to the group for one day
29) Invite the NGO/ social group to address their university students for couple of hours. Plan the entire event, decide a suitable venue in the university, gather audience, invite faculty members etc. (they need to get their plan ratified their professor). Outcome-- Host an interactive session with the NGO spokesperson
30) The groups to present their experience of a day with the NGO and inspire students to work for the cause.

Course learning outcome (CLO) / Course Objectives (COs):

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

1. Apply the basic concept of speed reading, skimming and scanning.
2. Use tools of structured written communication
3. Articulate opinions on a topic with the objective of influencing others
4. Create communication material to share concepts and ideas
5. Recognize the concepts of outward behavior and internal behavior

Text Books:

1. ETHICS FUNDAMENTALS AND APPROACHES TO ETHICS https://www.eolss.net/Sample-Chapters/C14/E1-37-01-00.pdf
2. A Framework for Making Ethical Decisions https://www.brown.edu/academics/science-and-technology-studies/framework-making-ethical-decisions
3. Five Basic Approaches to Ethical Decision- http://faculty.winthrop.edu/meelerd/docs/rolos/5_Ethical_Approaches.pdf

Reference Books:

1. Dr. A.P.J Abdul Kalam, Guiding Souls : Dialogues on the purpose of life; ;Publishing Year-2005
2. Dr. A.P.J Abdul Kalam, The Family and the Nation;; Publishing year: 2015.

UEN003: ENVIRONMENTAL SCIENCES

L	T	P	Cr
2	0	0	2.0

Course Objectives: The exposure to this course would facilitate the students in understanding the terms, definition, and scope of environmental and energy issues pertaining to the current global scenario. Understanding the values of regional and global natural and energy resources. Emphasize on the need for conservation of energy and environment

Definition and Scope: Importance, Public awareness and education.

Natural Resources: Introduction, Renewable and non-renewable, Forest, water, mineral, food, energy and land resources, Individual and conservation of resources, Equitable use of resources.
Ecosystems: Concept, Structure, Function, Energy flow, Ecological succession.

Biodiversity: Genetic, Species and ecological diversity, Biodiversity at global, national and local levels, Threats to biodiversity, Endangered and endemic species of India, Conservation of biodiversity.

Pollution: Definition, Pollution case studies, Causes, effects and control measures of the pollution – Air, Water, Noise, Thermal Pollution, Solid waste management, Disaster management.

Social Issues (through online platforms): Sustainable development, Environmental ethics, Climatic change, Environmental protection acts and issues.

Course learning outcome (CLO)/ Course Objectives (COs):
Upon completion of this course, the students will be able to:

1. Comprehend the interdisciplinary context with reference to the environmental issues and case studies
2. Assess the impact of anthropogenic activities on the various elements of environment and apply suitable techniques to mitigate their impact
3. Conceptualize and explain the structural and functional features of ecological systems.

Text Books:

1. Bharucha, E., Textbook of Environmental Studies, Universities Press (2005).
2. Chapman, J.L. and Reiss, M.J., Ecology- Principles and Application, Cambridge University Press (LPE) (1999).
3. Joseph, B., Environmental Studies, Tata McGraw-Hill (2006).

Reference Books:

1. Miller, G.T., Environmental Science- Working with Earth, Thomson (2006).
2. Wright, R.T., Environmental Science-Towards a sustainable Future, Prentice Hall (2008) 9th ed.

UCT301: FORMAL LANGUAGE AND AUTOMATA THEORY

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.

Introduction: Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages.

Regular languages and finite automata: Regular expressions and languages, deterministic finite automata (DFA) and equivalence with regular expressions, nondeterministic finite automata (NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, properties of regular languages, Kleene‟s theorem, pumping lemma for regular languages, Myhill-Nerode theorem and its uses, minimization of finite automata.

Context-free languages and pushdown automata: Context-free grammars (CFG) and languages (CFL), Chomsky and Greibach normal forms, nondeterministic pushdown automata (PDA) and equivalence with CFG, parse trees, ambiguity in CFG, pumping lemma for context-free languages, deterministic pushdown automata, closure properties of CFLs.

Context-sensitive languages: Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.

Turing machines: The basic model for Turing machines (TM), Turing recognizable(recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, unrestricted grammars and equivalence with Turing machines, TMsas enumerators.

Undecidability: Church-Turing thesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice s theorem, undecidable problems about languages.

Basic Introduction to Complexity: Introductory ideas on Time complexity of deterministic and nondeterministic Turing machines, P and NP, NP- completeness, Cook‟s Theorem, other NP - Complete problems.

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

After the completion of the course, the student 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 and their complexities.
4. Distinguish different computing languages and un-decidability problems in various types of languages.

Text Books:

1. Introduction to the Theory of Computation, Michael Sipser.
2. Introduction to Languages and the Theory of Computation, John Martin.

Reference Books:

1. Introduction to Automata Theory, Languages, and Computation John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman.
2. Elements of the Theory of Computation, Harry R. Lewis and Christos H. Papadimitriou.
3. Automata and Computability, Dexter C. Kozen.
4. Computers and Intractability: A Guide to the Theory of NP Completeness, M. R. Garey and D. S. Johnson.

UCT302: COMPUTER ORGANIZATION &ARCHITECHTURE

L	T	P	Cr
3	0	2	4.0

Course Objectives: To provide an understanding of the basic concepts of computer architecture and organization of the basic computer modules viz controls unit, central processing unit, input-output organization and memory unit.

Revision of basics in Boolean logic and Combinational/Sequential Circuits.

Functional blocks of a computer: CPU, memory, input-output subsystems, control unit.

Instruction set architecture of a CPU: Registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Outlining instruction sets of some common CPUs.

Data representation: Signed number representation, fixed and floating-point representations, character representation.

Computer arithmetic: Integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication – shift-and-add, Booth multiplier, carry save multiplier, etc. Division restoring and non-restoring techniques, floating point arithmetic, IEEE 754 format.

Introduction to x86 architecture.

CPU control unit design: Hardwired and micro-programmed design approaches, design of a simple hypothetical CPU.

Memory system design: Semiconductor memory technologies, memory organization.

Peripheral devices and their characteristics: Input-output subsystems, I/O device interface, I/O transfers – program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes – role of interrupts in process state transitions, I/O device interfaces – SCII, USB

Pipelining: Basic concepts of pipelining, throughput and speedup, pipeline hazards.

Parallel Processors: Introduction to parallel processors, Concurrent access to memory and cache coherency.

Memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.

Laboratory work: Installing software development toolkit for ARM processor-based microcontrollers, Assembly language programming for ARM processors.

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

After the completion of the course, the student 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. Comprehend the design of basic computer using instruction formats & addressing modes.
3. Identify various memory management techniques and algorithms for performing addition, subtraction and multiplication etc.
4. Acquire the knowledge about pipelining, multiprocessors, and input-output organization.

Text Books:

1. M. M. Mano, Computer System Architecture, Prentice Hall of India, New Delhi, (1993) 3rd ed..
2. David A. Patterson and John L. Hennessy. Computer Organization and Design: The Hardware/Software Interface (19993), 2nd ed..
3. Carl Hamacher. Computer Organization and Embedded Systems, (1998), 6th ed.

Reference Books:

1. John P. Hayes. Computer Architecture and Organization, (1998), 3rd ed.
2. William Stallings. Computer Organization and Architecture: Designing for Performance, (2002), 6th ed.
3. Vincent P. Heuring and Harry F. Jordan Computer System Design and Architecture, (1996), 2nd ed.

UCT303: 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.

Procedural programming, An Overview of C: Types Operator and Expressions, Scope and Lifetime, Constants, Pointers, Arrays, and References, Control Flow, Functions and Program Structure, Namespaces, error handling, Input and Output (*C*-way), Library Functions (*string*, *math*, *stdlib*), Command line arguments, Pre-processor directive

Some difference between C and C++: Single line comments, Local variable declaration within function scope, function declaration, function overloading, stronger type checking, Reference variable, parameter passing – value vs reference, passing pointer by value or reference, Operator new and delete, the typecasting operator, Inline Functions in contrast to macro, default arguments

The Fundamentals of Object Oriented Programming: Necessity for OOP, Data Hiding, Data Abstraction, Encapsulation, Procedural Abstraction, Class and Object.

More extensions to C in C++ to provide OOP Facilities: Scope of Class and Scope Resolution Operator, Member Function of a Class, private, protected and public Access Specifier, this Keyword, Constructors and Destructors, friend class, error handling (exception)

Essentials of Object Oriented Programming: Operator overloading, Inheritance – Single and Multiple, Class Hierarchy, Pointers to Objects, Assignment of an Object to another Object, Polymorphism through dynamic binding, Virtual Functions, Overloading, overriding and hiding, Error Handling

Generic Programming: Template concept, class template, function template, template specialization

Input and Output: Streams, Files, Library functions, formatted output

Object Oriented Design and Modelling: UML concept, Use case for requirement capturing, Class diagram, Activity diagram and Sequence Diagram for design, Corresponding C++ code from design

Laboratory

To implement Programs for various kinds of programming constructs in C++ Language.

Course Learning Outcomes (CLOs):

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

1. Understand the basic concept of Classes, objects and Object Orientation, with basic layout of an object oriented program.
2. Comprehend the concept of constructors and destructors.

3. Demonstrate the prime concepts viz. overloading, polymorphism, abstraction and Inheritance of an object oriented paradigm.
4. Use template and Exception handling in an object oriented programming.
5. Grasp the File handling concepts and be able to use files.

Text Books:

1. The C++ Programming Language, Bjarne Stroustrup, Addison Wesley.
2. C++ and Object-Oriented Programming Paradigm, Debasish Jana, PHI Learning Pvt. Ltd.

Reference Books:

1. Lafore R., Object-Oriented Programming in C++, Pearson Education (2002) 4th ed.
2. E Balagurusamy, Object Oriented Programming with C++ (2017) 7th ed.
3. Schildt H., C++: The Complete Reference, Tata McGraw Hill (2003) 4th ed.

UCT304: COMPUTATIONAL STATISTICS

L	T	P	Cr
3	1	2	4.5

Course Objectives: To provide an understanding of Multivariate Normal distribution, multiple linear regression model, Multivariate regression, Discriminant analysis, Principal component analysis, Factor analysis and Cluster analysis.

Multivariate Normal Distribution: Multivariate Normal Distribution Functions, Conditional Distribution and its relation to regression model, Estimation of parameters.

Multiple Linear Regression Model: Standard multiple regression models with emphasis on detection of collinearity, outliers, non-normality and autocorrelation, Validation of model assumptions.

Multivariate Regression: Assumptions of Multivariate Regression Models, Parameter estimation, Multivariate Analysis of variance and covariance

Discriminant Analysis: Statistical background, linear discriminant function analysis, Estimating linear discriminant functions and their properties.

Principal Component Analysis: Principal components, Algorithm for conducting principal component analysis, deciding on how many principal components to retain, H-plot.

Factor Analysis: Factor analysis model, Extracting common factors, determining number of factors, Transformation of factor analysis solutions, Factor scores.

Cluster Analysis: Introduction, Types of clustering, Correlations and distances, clustering by partitioning methods, hierarchical clustering, overlapping clustering, K-Means Clustering-Profiling and Interpreting Clusters.

Laboratory Work:

Python Concepts, Data Structures, Classes: Interpreter, Program Execution, Statements, Expressions, Flow Controls, Functions, Numeric Types, Sequences and Class Definition, Constructors, Text & Binary Files - Reading and Writing

Visualization in Python: Matplotlib package, Plotting Graphs, Controlling Graph, Adding Text, More Graph Types, Getting and setting values, Patches

Multivariate data analysis: Multiple regression, multivariate regression, cluster analysis with various algorithms, factor analysis, PCA and linear discriminant analysis. Various datasets should be used for each topic

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

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

- Formulate the real world problems and find its statistical solutions.
- Apply basic concept of the Multivariate Normal Distribution, Estimation of parameters, Conditional Distribution and its relation to regression model.
- Learn about the Multivariate Regression, Multivariate Analysis of variance and covariance, linear discriminant function analysis and their fundamental relationship with computer science.
- Apply the principal component analysis on vector and matrix data, deciding on how many principal components to retain, H-plot.
- Illustrate and apply the important features of clustering, correlations and distances, clustering by partitioning methods, hierarchical clustering, overlapping clustering, K-Means Clustering-Profiling and Interpreting Clusters in the practical applications like prediction of brain diseases using machine learning.

Text Books:

1. An Introduction to Multivariate Statistical Analysis, T.W. Anderson.
2. Applied Multivariate Data Analysis, Vol I & II, J.D. Jobson.
3. Statistical Tests for Multivariate Analysis, H. Kris.
4. Programming Python, Mark Lutz.
5. Python 3 for Absolute Beginners, Tim Hall and J-P Stacey.
6. Beginning Python: From Novice to Professional, Magnus Lie Hetland. Edition, 2005.

Reference Books:

1. Regression Diagnostics, Identifying Influential Data and Sources of Collinearety, D.A. Belsey, E. Kuh and R.E. Welsch
2. Applied Linear Regression Models, J. Neter, W. Wasserman and M.H. Kutner.
3. The Foundations of Factor Analysis, A.S. Mulaik.
4. Introduction to Linear Regression Analysis, D.C. Montgomery and E.A. Peck.
5. Cluster Analysis for Applications, M.R. Anderberg.
6. Multivariate Statistical Analysis, D.F. Morrison.
7. Python for Data Analysis, Wes Mc Kinney.

UCT305: SOFTWARE ENGINEERING

L	T	P	Cr
3	0	2	4.0

Course Objectives: To understand, analyze, specify and manage software requirements by applying principles of software development and evolution. To design, implement and test software using object oriented principles and quality standards.

Introduction: Programming in the small vs. programming in the large; software project failures and importance of software quality and timely availability; engineering approach to software development; role of software engineering towards successful execution of large software projects; emergence of software engineering as a discipline.

Software Project Management: Basic concepts of life cycle models – different models and milestones; software project planning –identification of activities and resources; concepts of feasibility study; techniques for estimation of schedule and effort; software cost estimation models and concepts of software engineering economics; techniques of software project control and reporting; introduction to measurement of software size; introduction to the concepts of risk and its mitigation; configuration management.

Software Quality and Reliability: Internal and external qualities; process and product quality; principles to achieve software quality; introduction to different software quality models like McCall, Boehm, FURPS / FURPS+, Dromey, ISO – 9126; introduction to Capability Maturity Models (CMM and CMMI); introduction to software reliability, reliability models and estimation.

Software Requirements Analysis, Design and Construction: Introduction to Software Requirements Specifications (SRS) and requirement elicitation techniques; techniques for requirement modeling – decision tables, event tables, state transition tables, Petri nets; requirements documentation through use cases; introduction to UML, introduction to software metrics and metrics based control methods; measures of code and design quality.

Object Oriented Analysis, Design and Construction: Concepts -- the principles of abstraction, modularity, specification, encapsulation and information hiding; concepts of abstract data type; Class Responsibility Collaborator (CRC) model; quality of design; design measurements; concepts of design patterns; Refactoring; object oriented construction principles; object oriented metrics.

Software Testing: Introduction to faults and failures; basic testing concepts; concepts of verification and validation; black box and white box tests; white box test coverage – code coverage, condition coverage, branch coverage; basic concepts of black-box tests – equivalence classes, boundary value tests, usage of state tables; testing use cases; transaction based testing; testing for non-functional requirements – volume, performance and efficiency; concepts of inspection.

Laboratory Work:

Development of requirements specification, function oriented design using SA/SD, object-oriented design using UML, test case design, implementation using C++ and testing. Use of appropriate CASE tools and other tools such as configuration management tools, program analysis tools in the software life cycle.

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

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

- Analyze software requirements through various tools like DFD and Use Case diagrams for creating SRS.
- Develop software design model using Object oriented analysis and design concepts.
- Apply testing techniques to test the software functionality and non-functional requirements.
- Achieve Software quality through quality standards and Models.
- Demonstrate project management by software planning and estimations.

Text Books:

1. Software Engineering, Ian Sommerville.

Reference Books:

1. *Fundamentals of Software Engineering,* Carlo Ghezzi, Jazayeri Mehdi, Mandrioli Dino
2. *Software Requirements and Specification: A Lexicon of Practice, Principles and Prejudices*, Michael Jackson
3. *The Unified Development Process*, Ivar Jacobson, Grady Booch, James Rumbaugh
4. *Design Patterns: Elements of Object-Oriented Reusable Software*, Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides
5. *Software Metrics: A Rigorous and Practical Approach*, Norman E Fenton, Shari Lawrence Pfleeger
6. *Software Engineering: Theory and Practice*, Shari Lawrence Pfleeger and Joanne M. Atlee
7. *Object-Oriented Software Construction,* Bertrand Meyer
8. *Object Oriented Software Engineering: A Use Case Driven Approach* --Ivar Jacobson
9. *Touch of Class: Learning to Program Well with Objects and Contracts* --Bertrand Meyer
10. *UML Distilled: A Brief Guide to the Standard Object Modeling Language* --Martin Fowler.

UCT401: OPERATING SYSTEMS

L	T	P	Cr
3	0	2	4.0

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

Introduction and System Structures: Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Computing Environments, Operating-System Services, User and Operating-System Interface, System Calls, Types of System Calls, System Programs, Operating-System Design and Implementation, Operating-System Structure.

Process Management: Process Concept, Process Scheduling, Operations on Processes, Inter-process Communication, Multi-threaded programming: Multi-core Programming, Multithreading Models, Process Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Algorithm Evaluation.

Deadlock: 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, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing, Allocating Kernel Memory.

File Systems: File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing, Protection, File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, and Free-Space Management.

Disk Management: Mass Storage Structure, Disk Structure, Disk Attachment, Disk Scheduling, Disk Management, Swap-Space Management, RAID Structure.

Protection and Security: Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix, Implementation of the Access Matrix, Access Control, Revocation of Access Rights, Capability-Based Systems, the Security Problem, Program Threats, System and Network Threats, User Authentication, Implementing Security Defenses, Firewalling to Protect Systems and Networks.

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

Laboratory work:

To explore detailed architecture and shell commands in Linux / Unix environment, and to simulate CPU scheduling, Paging, Disk-scheduling and process synchronization algorithms.

Course learning outcome (CLO) / Course Objectives (COs):

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

1. Explain the basic of an operating system viz. system programs, system calls, user mode and kernel mode.
2. Select a particular CPU scheduling algorithm for specific situation, and analyze the environment leading to deadlock and its rectification.
3. Explicate memory management techniques viz. caching, paging, segmentation, virtual memory, and thrashing.
4. Understand the concepts related to file systems, disk-scheduling, and security, protection.
5. Comprehend the concepts related to concurrency.

Text Books:

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

Reference Books:

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

UCT402: DATATBASE MANGEMENT SYSTEMS

L	T	P	Cr
3	0	2	4.0

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

Introduction: Introduction to Database, Hierarchical, Network and Relational Models.

Database system architecture: Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML).

Data models: Entity-relationship model, network model, relational and object oriented data models, integrity constraints, data manipulation operations.

Relational query languages: Relational algebra, Tuple and domain relational calculus, SQL3, DDL and DML constructs, Open source and Commercial DBMS - MYSQL, ORACLE, DB2, SQL server.

Relational database design: Domain and data dependency, Armstrong's axioms, Functional Dependencies, Normal forms, Dependency preservation, Lossless design.

Query processing and optimization: Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms.

Storage strategies: Indices, B-trees, Hashing.

Transaction processing: Concurrency control, ACID property, Serializability of scheduling, Locking and timestamp based schedulers, Multi-version and optimistic Concurrency Control schemes, Database recovery.

Database Security: Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, SQL injection.

Advanced topics: Object oriented and object relational databases, Logical databases, Web databases, Distributed databases, Data warehousing and data mining.

Laboratory work:
Students will perform SQL commands to demonstrate the usage of DDL and DML, joining of tables, grouping of data etc. 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. Project should have continuous evaluation and should be spread over different components.

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

1. Analyze the basics of Database management Systems, its need and advantages as compared to traditional file-based systems.
2. Analyze and design of database using data models like E-R by identifying entities, attributes and relationships.
3. Demonstrate use of the SQL with Data Definition Language (DDL), Data Manipulation Language (DML).
4. Apply and create Relational Database Design process with Normalization and Denormalization of data.
5. Comprehend the concepts of transaction management, concurrency control and recovery management.

Text Books:
1. Database System Concepts. Abraham Silberschatz, Henry F. Korth and S. Sudarshan.

Reference Books:
1. Principles of Database and Knowledge Base Systems, Vol 1 by J. D. Ullman.
2. Fundamentals of Database Systems. R. Elmasri and S. Navathe.
3. Foundations of Databases. Serge Abiteboul, Richard Hull, Victor Vianu.

UCT403: SOFTWARE DESIGN WITH UML

L	T	P	Cr
2	0	2	3.0

Course Objectives: To apply principles of software development and evolution. To specify, abstract, verify, validate, plan, develop and manage large software and learn emerging trends in software engineering

Introduction to an Object Oriented Technologies and the UML Method. : Software development process: The Waterfall Model vs. The Spiral Model. The Software Crisis, description of the real world using the Objects Model. Classes, inheritance and multiple configurations. Quality software characteristics. Description of the Object Oriented Analysis process vs. the Structure Analysis Model.

Introduction to the UML Language: Standards. Elements of the language. General description of various models. The process of Object Oriented software development. Description of Design Patterns. Technological Description of Distributed Systems.

Requirements Analysis Using Case Modeling: Analysis of system requirements. Actor definitions. Writing a case goal. Use Case Diagrams. Use Case Relationships.

Transfer from Analysis to Design in the Characterization Stage: Interaction Diagrams. Description of goal. Defining UML Method, Operation, Object Interface, Class. Sequence Diagram. Finding objects from Flow of Events. Describing the process of finding objects using a Sequence Diagram. Describing the process of finding objects using a Collaboration Diagram.

The Logical View Design Stage: The Static Structure Diagrams. : The Class Diagram Model. Attributes descriptions. Operations descriptions. Connections descriptions in the Static Model. Association, Generalization, Aggregation, Dependency, Interfacing, Multiplicity.

Package Diagram Model: Description of the model. White box, black box. Connections between packagers. Interfaces. Create Package Diagram. Drill Down.

Dynamic Model: State Diagram / Activity Diagram: Description of the State Diagram. Events Handling. Description of the Activity Diagram. Exercise in State Machines.

Component Diagram Model & Deployment Model: Physical Aspect. Logical Aspect. Connections and Dependencies. User face. Initial DB design in a UML environment. Processors. Connections. Components. Tasks. Threads. Signals and Events.

Laboratory work: Implementation of Software Engineering concepts and exposure to CASE tools like Rational Software suit, Turbo Analyst, Silk Suite. Follow entire SDLC depending on project domain.

Course learning outcomes (CLOs):

Upon the completion of the course, the student will be able to:

1. Comprehend software development all modern process models, including traditional models like waterfall and spiral.
2. Demonstrate the use of software life cycle through requirements gathering, choice of process model and design model.
3. Apply and use various UML models for software analysis, design and testing.
4. Acquire knowledge about the concepts of application of case tools and configuration management for software development.

Text Books:

1. Object-Oriented Software Engineering: using UML, Patterns, and Java. Bernd Bruegge and Allen H. Dutoit.
2. Pressman S. R. and Maxim R. B., Software Engineering, A Practitioner‟s Approach, McGraw Hill International (2015) 8th Edition.
3. Sommerville I., Software Engineering, Addison-Wesley Publishing Company (2011) 9th Edition

Reference Books:

1. Foster C. E., Software Engineering: A Methodical Approach, Apress (2014)1st ed.
2. Booch G., Rambaugh J., Jacobson I., The Unified Modeling Language User Guide (2005) 2nd Edition.

UHU023: INTRODUCTION TO INNOVATION, IP MANAGEMENT & ENTREPRENEURSHIP

L	T	P	Cr
3	0	0	3.0

Course Objectives: The major emphasis of the course will be on creating a learning system through which the students can enhance their innovation and creative thinking skills, acquaint themselves with the special challenges of starting new ventures and use IPR as an effective tool to protect their innovations and intangible assets from exploitation.

Innovation: A Primer on Innovation, IP Rights and Entrepreneurship; Types of Innovation: Incremental, Radical and Disruptive; Lifecycle of Innovation; Challenges in Innovation

Intellectual Property Rights: Types of IPRs; Lifecycle of IP; Balancing IP Risks and Rewards

Technology Entrepreneurship: Opportunity identification in Technology Entrepreneurship

Market Research: Market Research, Segmentation and Sizing; Product Positioning, Pricing and Go to Market Strategy

Innovation Assessment: Patentability Analysis

IP Valuation: Methods, Examples, Limitations

Business Models: Start-up Business Models (Fund Raising; Market Segments Channels etc.

Co-Innovation and Open Innovation: Academia: Startups; Corporates

Technology Innovation –two case studies

Innovation, Incubation and Entrepreneurship: Corporate context

Technology driven Social Innovation & Entrepreneurship

Mange Innovation, IP and Entrepreneurship Programs: Processes; Governance and Tools

Project: Students are to bring case study on Startup for discussion (new product business of an enterprise) or prepare a business case to setup a new technology-led business as startup (or new product business of an enterprise.)

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

The course intends to introduce students to the fundamentals of technology innovation, Intellectual property rights and entrepreneurship. The successful completion of this course will help students to:

1. Identify and discover market needs.
2. Acquaint them with skills to manage an Innovation Program.
3. Acquaint them with skills to create, protect, assetize and commercialize Intellectual Property.
4. Analyze Opportunities and Challenges for Entrepreneurs.

Text Books:

1. Joe Tidd, John Bessant. Managing Innovation: Integrating Technological, Market and Organizational Change
2. Case Study Materials: To be distributed for class discussion

UHU024: DESIGN THINKING

L	T	P	Cr
2	0	2	3.0

Course Objectives:

1	Recognize the importance of DT
2	Explain the phases in the DT process
3	List the steps required to complete each phase in DT process
4	Apply each phase in the DT process
5	Use doodling and storytelling in presenting ideas and prototypes
6	Create value proposition statements as part of their presentations
7	Recognize how DT can help in functional work
8	Recognize how Agile and DT complement each other to deliver customer satisfaction

Why is Design thinking important for business?

Stories and examples will be used to introduce Design Thinking to the participants. We will use relevant stories and the following videos.

1. YouTube video: The Design Thinking Process – Sprouts (3.57 mins)
2. Leverage TCS-provided DT content to show the evolution of DT and why is important in present business environment. Can be a video. (2 mins)
3. Lecturer to encourage the students to maintain their Satori slam book and capture their learning points in it.

Leverage TCS-provided DT content to show the evolution of DT and why is important in present

Why is Design Thinking important for you?

Experiential activity

Products that you loved and hated: In this activity, learners will have to share about a product they like of disliked based on their experience.

What would they need in a bad product to make it good?

What is DT?

Introduce the 5-Step Stanford Model using YouTube videos:

The video will give a brief idea about the five steps:

- Empathize (search for rich stories and find some love)
- Define (user need and insights – their POV)
- Ideate (ideas, ideas, ideas)
- Prototype (build to learn)
- Test (show, don‟t tell)

Start all over and iterate the flow as much as possible

What is empathy?

Touch the target activity (Recap from Sem 2 Unit 4)

Discussions in class

Reference: FHIL | Stages of Design Thinking | EMPATHY

Laboratory Work:
Immersion activity

Participants will be divided into four groups. Each group will need to visit any one of the following places to conduct an immersion activity. They need to interview people and fill up the DT question template (explained in the last class)

1. College cafeteria
2. College library
3. College sports facility
4. Transport facility near college

Creating personas

Start with YouTube videos explaining the process of persona creation:

1. Personas – What is a persona and how do I create one? (2019)

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

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

1. Recognize the importance of Design Thinking; identify the steps in the DT process.
2. Recognize the steps in the empathize phase of DT.
3. Create personas in the define phase of DT
4. Recognize how Agile and DT complement each other to deliver customer satisfaction

Textbooks:	
	There are no prescribed texts for Semester 4 – there will be handouts and reference links shared.
Reference Books:	
1	Hooked by NirEyal
2	The Art of Creative Thinking by Rod Judkins
3	Start Up nation by Dan Senor and Saul singer

4	Start with Why by Simon Sinek
Web References:	
1	What is Design Thinking? Interaction Design Foundation
2	What are some of the good examples of design thinking? – Quora
3	Design thinking 101: Principles, Tools & Examples to transform your creative process
Online Resources:	
1	Understanding Design thinking WF NEN
2	Design Thinking and Innovation at Apple Wei Li
3	Stanford Webinar- Design Thinking = Method, Not Magic
4	Stanford Design Thinking Virtual Crash Course
5	So Many Uses- activity to spark creativity and design

UMA019: OPERATIONS RESEARCH

L	T	P	Cr
3	0	2	4.0

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 linear programming problems, Assignment problem, Transportation problem, Project management techniques using PERT and CPM, Inventory control, Queuing theory and simulation methodology.

Introduction to OR:
Origin of OR and its definition. Concept of optimizing performance measure, Types of OR problems, Deterministic vs. Stochastic optimization, Phases of OR problem approach – problem formulation, building mathematical model, deriving solutions, validating model, controlling and implementing solution.

Linear Programming:
Linear programming – Examples from industrial cases, formulation & definitions, Matrix form. Implicit assumptions of LPP.
Hyperplane, Convex set, convex polyhedron, Extreme points, Basic feasible solutions. Geometric method: 2-variable case, Special cases – infeasibility, unboundedness, redundancy & degeneracy, Sensitivity analysis.
Simplex Algorithm – slack, surplus & artificial variables, computational details, big-M method, identification and resolution of special cases through simplex iterations.
Duality – formulation, results, fundamental theorem of duality, dual-simplex and primal-dual algorithms.

Transportation and Assignment problems:
TP - Examples, Definitions – decision variables, supply & demand constraints, formulation, Balanced & unbalanced situations, Solution methods – NWCR, minimum cost and VAM, test for optimality (MODI method), degeneracy and its resolution.
AP - Examples, Definitions – decision variables, constraints, formulation, Balanced &unbalanced situations, Solution method – Hungarian, test for optimality (MODI method), degeneracy & its resolution.

PERT – CPM:
Project definition, Project scheduling techniques – Gantt chart, PERT & CPM, Determination of critical paths, Estimation of Project time and its variance in PERT using statistical principles, Concept of project crashing/time-cost trade-off.

Inventory Control:
Functions of inventory and its disadvantages, ABC analysis, Concept of inventory costs, Basics of inventory policy (order, lead time, and types), fixed order-quantity models – EOQ, POQ & Quantity discount models.

Queuing Theory:
Definitions – queue (waiting line), waiting costs, characteristics (arrival, queue, service discipline) of queuing system, queue types (channel vs. phase).
Kendall‟s notation, Little‟s law, steady state behaviour, Poisson‟s Process & queue, Models with examples - M/M/1 and its performance measures; M/M/m and its performance measures; brief description about some special models.

Simulation Methodology:
Definition and steps of simulation, random number, random number generator, Discrete Event System Simulation and Applications.

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

Course Learning Outcomes (CLOs) / Course Objectives (COs):
Upon completion of this course, the students would be able to:

1. Formulate and solve linear programming problems using Simplex method and its variants.
2. Construct and optimize various network models.
3. Classify and solve inventory models.
4. Categorize and modelling of queuing system.
5. Apply simulation technique to various problems.

Text Books:

1. Operations Research: An Introduction. H.A. Taha.

Reference Books:

1. Linear Programming. K.G. Murthy.
2. Linear Programming. G. Hadley.
3. Principles of OR with Application to Managerial Decisions. H.M. Wagner.
4. Introduction to Operations Research. F.S. Hiller and G.J. Lieberman.
5. Elements of Queuing Theory. Thomas L. Saaty.
6. Operations Research and Management Science, Hand Book: Edited By A. Ravi Ravindran.
7. Management Guide to PERT/CPM. Wiest & Levy.
8. Modern Inventory Management. J.W. Prichard and R.H. Eagle.

UHU025: MARKETING RESEARCH & MARKETING MANAGEMENT

L	T	P	Cr
2	0	0	2.0

Course Objectives: To provide an understanding of various concepts of marketing management and marketing research and understand their applicability for decision-making in organizations.

UNIT – I

Marketing Concepts and Applications: Introduction to Marketing & Core Concepts, Marketing of Services, Importance of marketing in service sector

Marketing Planning & Environment: Elements of Marketing Mix, Analyzing needs & trends in Environment - Macro, Economic, Political, Technical & Social

Understanding the consumer: Determinants of consumer behavior, Factors influencing consumer behavior

Market Segmentation: Meaning & Concept, Basis of segmentation, selection of segments, Market Segmentation strategies, Target Marketing, Product Positioning

UNIT – II

Product Management: Product Life cycle concept, New Product development & strategy, Stages in New Product development, Product decision and strategies, Branding & packaging

UNIT – III

Pricing, Promotion and Distribution Strategy: Policies & Practices – Pricing Methods & Price determination Policies. Marketing Communication – The promotion mix, Advertising & Publicity, 5 M‟s of Advertising Management. Marketing Channels, Retailing, Marketing Communication, Advertising

UNIT – IV

Marketing Research: Introduction, Type of Market Research, Scope, Objectives & Limitations

Marketing Research Techniques, Survey Questionnaire design & drafting, Pricing Research, Media Research, Qualitative Research

Data Analysis: Use of various statistical tools – Descriptive & Inference Statistics, Statistical Hypothesis Testing, Multivariate Analysis - Discriminant Analysis, Cluster Analysis, Segmenting and Positioning, Factor Analysis

UNIT – V

Internet Marketing: Introduction to Internet Marketing. Mapping fundamental concepts of Marketing (7Ps, STP); Strategy and Planning for Internet Marketing

UNIT – VI

Business to Business Marketing: Fundamental of business markets. Organizational buying process. Business buyer needs. Market and sales potential. Product in business markets. Price in business markets. Place in business markets. Promotion in business markets. Relationship, networks and customer relationship management. Business to Business marketing strategy

Home Assignments:

1. **Written Analyses of Cases** – Students are expected to report on their analysis and recommendations of what to do in specific business situations by applying concepts and principles learned in class (Case Studies to be shared by Faculty)
2. Field visit & live project covering steps involved in formulating Market Research Project
3. Measuring Internet Marketing Effectiveness: Metrics and Website Analytics

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

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

1. Understand basic marketing concepts.
2. Understand the dynamics of marketing and analyze how its various components interact with each other.
3. Apply marketing concepts for effective decision making.
4. Understand basic concepts and application of statistical tools in Marketing research.

Text Books:

1. Marketing Management (Analysis, Planning, Implementation & Control) – Philip Kotler
2. Fundamentals of Marketing – William J. Stanton & Others
3. Marketing Management – V.S. Ramaswamy and S. Namakumari
4. Marketing Research – Rajendra Nargundkar
5. Market Research – G.C. Beri
6. Market Research, Concepts, & Cases – Cooper Schindler

Reference Books:

1. Marketing Management – Rajan Saxena
2. Marketing Management – S.A. Sherlekar
3. Service Marketing – S.M. Zha
4. Journals – The IUP Journal of Marketing Management, Harvard Business Review
5. Research for Marketing Decisions by Paul Green, Donald, Tull
6. Business Statistics, A First Course, David M Levine at al, Pearson Publication

UCT501: DESIGN AND ANALYSIS OF ALGORITHMS

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of course is to provide an understanding of various techniques/methods such as Greedy, Dynamic Programming, Branch and Bound and Backtracking. It provides an insight of good principles of algorithm design techniques, and analysis of algorithms.

Introduction: Characteristics of Algorithm. Analysis of Algorithm: Asymptotic analysis of Complexity Bounds – Best, Average and Worst-Case behavior; Performance Measurements of Algorithm, Time and Space Trade-Offs, Analysis of Recursive Algorithms through Recurrence Relations: Substitution Method, Recursion Tree Method and Masters‟ Theorem.

Fundamental Algorithmic Strategies: Brute-Force, Heuristics, Greedy, Dynamic Programming, Branch and Bound and Backtracking methodologies; Illustrations of these techniques for Problem-Solving, Bin Packing, Knapsack, Travelling Salesman Problem.

Graph and Tree Algorithms: Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm.

Tractable and Intractable Problems: Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook‟s theorem, Standard NP-complete problems and Reduction techniques.

Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems beyond NP – P SPACE, Introduction to Quantum Algorithms.

Laboratory Work:

Implementation of Different Algorithms based on various algorithmic strategies using C/C++.

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

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

1. Analyze the complexity of algorithms, to provide justification for the selection, and to implement the algorithm in a particular context.
2. Apply various algorithmic design paradigms such as greedy, dynamic, backtracking etc. to solve common engineering problems.
3. Identify basic properties of graphs and apply their algorithms to solve real life problems.

Text Books:

1. Fundamental of Computer Algorithms, E. Horowitz and S. Sahni.

2. The Design and Analysis of Computer Algorithms, A. Aho, J. Hopcroft and J. Ullman.

Reference Books:

1. Introduction to Algorithms, T. H. Cormen, C. E. Leiserson and R. L. Rivest.
2. Computer Algorithms: Introduction to Design and Analysis, S. Baase.
3. The Art of Computer Programming, Vol. 1, Vol. 2 and Vol. 3, .D. E. Knuth.
4. Quantum Computation and Quantum Information, Michael A. Nielsen and Isaac L. Chuang.

UCT502: COMPILER DESIGN

L	T	P	Cr
3	0	2	4.0

Course Objectives: To Gain the working knowledge of the major phases of compilation and develop the ability to use formal attributed grammars for specifying the syntax and semantics of programming languages. Learn about function and complexities of modern compilers and design a significant portion of a compiler.

Introduction: Phases of compilation and overview. Lexical Analysis (scanner): Regular languages, finite automata, regular expressions, relating regular expressions and finite automata, scanner generator (lex, flex).
Syntax Analysis (Parser): Context-free languages and grammars, push-down automata, LL(1) grammars and top-down parsing, operator grammars, LR(O), SLR(1), LR(1), LALR(1) grammars and bottom-up parsing, ambiguity and LR parsing, LALR(1) parser generator (yacc, bison)
Semantic Analysis: Attribute grammars, syntax directed definition, evaluation and flow of attribute in a syntax tree.
Symbol Table: Basic structure, symbol attributes and management. Run-time environment: Procedure activation, parameter passing, value return, memory allocation, scope.
Intermediate Code Generation: Translation of different language features, different types of intermediate forms.
Code Improvement (optimization): control-flow, data-flow dependence etc.; local optimization, global optimization, loop optimization, peep-hole optimization etc.
Architecture dependent code improvement: instruction scheduling (for pipeline), loop optimization (for cache memory) etc. Register allocation and target code generation.
Advanced topics: Type systems, data abstraction, compilation of Object Oriented features and non-imperative programming languages.

Laboratory Work:

Assignments using Lex and Yaac

Course Learning Outcomes (CLOs) / Course Objectives (COs):
After the completion of the course, the student will be able to:

1. In-depth knowledge of working of major phases of compiler.
2. Parser construction using top-down and bottom-up parsing techniques.
3. Classify various parameters passing scheme, explain memory management techniques.
4. Apply code optimization techniques on HLL.

Text Books:

1. Compilers: Principles, Techniques and Tools, V. Aho, R. Sethi and J. Ullman.
2. Lex &Yacc, Levine R. John, Tony Mason and Doug Brown.

Reference Books:

1. The Design and Evolution of C++, Bjarne Stroustrup.

UHU029: FUNDAMENTALS OF MANAGEMENT

L	T	P	Cr
2	0	0	2.0

Course Objectives: To provide an understanding of evolution of management thought, management theories and functions; organizational behavior, organizational design and organization structure; managerial ethics and leadership.

Management Theories: Concept and Foundations of Management, Evolution of Management Thoughts [Pre-Scientific Management Era (before 1880), Classical management Era (1880-1930), Neo-classical Management Era (1930-1950), Modern Management era (1950-on word). Contribution of Management Thinkers: Taylor, Fayol, Elton Mayo etc.

Functions of Management: Planning, Organizing, Staffing, Directing, Controlling.

Organization Behavior: Introduction, Personality, Perception, Learning and Reinforcement, Motivation, Group Dynamics, Power & Influence, Work Stress and Stress Management, Decision Making, Problems in Decision Making, Decision Making, Organizational Culture, Managing Cultural Diversity.

Organizational Design: Classical, Neoclassical and Contingency approaches to organizational design; Organizational theory and design, Organizational structure (Simple Structure, Functional Structure, Divisional Structure, Matrix Structure)

Managerial Ethics: Ethics and Business, Ethics of Marketing & advertising, Ethics of Finance &Accounting, Decision-making frameworks, Business and Social Responsibility, International Standards, Corporate Governance, Corporate Citizenship, Corporate Social Responsibility.

Leadership: Concept, Nature, Importance, Attributes of a leader, developing leaders across the organization, Leadership Grid.

Home Assignment:

The topic for class discussion will be mentioned beforehand and students should be ready to discuss these topics (in groups) in class. Students are required to meet in groups before coming to class and prepare on the topic. Few topics are mentioned below as examples.

1. Topic: Corporate social responsibility (CSR) and HRM implications: What does it mean to be socially responsible within an increasingly financially driven market economy?
2. Topic: Leaders are Born, Not Made!

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

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

1. Understand the evolution of management thought, contribution of management thinkers, management theories and management functions.
2. Understand the significance of various aspects of organizational behavior such as perception, learning, motivation, stress management, and decision-making.

3. Understand the various approaches to organizational design and different types of organizational structure.
4. Understand the importance of managerial ethics, corporate social responsibility and leadership.

Text Book:

1. Richard L. Daft, Understanding the Theory and Design of Organizations.

Reference Book:

1. Stephen P. Robbins, Timothy A. Judge, Neharika Vohra, Organizational Behavior.

UHU030: BUSINESS STRATEGY

L	T	P	Cr
2	0	0	2.0

Course Outcome(s): To provide an understanding of various business strategy concepts and different tools available for better comprehension of real life business environment. To assist the learners in analyse existing strategies and developing capabilities for innovative and practical strategic approaches.

Introduction to Strategic Management: Importance of Strategic Management**,** Vision and Objectives**,** Schools of thought in Strategic Management**,** Strategy Content, Process, and Practice**,** Fit Concept and Configuration Perspective in Strategic Management
External Environments of Firm- Competitive Strategy: Five Forces of Industry Attractiveness that Shape Strategy**,** The concept of Strategic Groups, and Industry Life Cycle**,** Generic Strategies**,** Generic Strategies and the Value Chain
Internal Environment of Firm- Recognizing a Firm's Intellectual Assets: Core Competence as the Root of Competitive Advantage**,** Sources of Sustained Competitive Advantage**,** Business Processes and Capabilities-based Approach to Strategy
Corporate Strategy and Growth Strategies: The Motive for Diversification**,** Related and Unrelated Diversification**,** Business Portfolio Analysis**,** Expansion, Integration and Diversification**,** Strategic Alliances, Joint Ventures, and Mergers & Acquisitions
Strategy Implementation: Structure and Systems: The 7S Framework**,** Strategic Control and Corporate Governance

Home Assignment:

- Latest business events would be discussed in class and students should be ready to discuss these events (in groups). The topic will be mentioned beforehand. Students are required to meet in groups before coming to class and prepare on the topic.
- There will be periodic homework assignments relating to the course concepts or mini-cases. Specific instructions will be given separately.

Final Project:
Students (in groups) are required to work on a project and submit the project report and deliver presentation. The topic of the project will be given later.

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

1. Comprehend the fundamental concepts of strategic management.
2. Analyze business situations and can apply these concepts to solve business problems.
3. Appreciate the fundamental principles of and interrelationships among business functions such as: R&D, production, marketing, finance, HR and information technology.

4. Comprehend the inter-relationships of business to individuals, other organizations, Government and society.
5. Develop capabilities to analyze complex, unstructured qualitative and quantitative problems, using appropriate tools.

Text Books:

1. Robert M. Grant (2012). Contemporary Strategic Management, Blackwell, 7th Edition.
2. Fred R. David (2011). Strategic management: concepts and cases, 13th Edition.

Reference Books:

1. M.E. Porter, Competitive Strategy, 1980.M.E. Porter.
2. Competitive Advantage, 1985 Richard Rumelt (2011).
3. Good Strategy Bad Strategy: The Difference and Why It Matters.

UHU042: BUSINESS COMMUNICATION & VALUE SCIENCE-III

L	T	P	Cr
1	0	2	2.0

Course Objectives: To introduce students to Self-analysis techniques like SWOT & TOWS, the power of motivation in real life and to key concepts of: a) Pluralism & cultural spaces b) Cross-cultural communication c) Science of Nation. To develop technical writing skills.

Self-analysis techniques: Tools for self analysis like SWOT & TOWS**;** SWOT in real life; SWOT and Life Positions; how it relates to SWOT and creating your own SWOT. Research on TOWS. SWOT vs. TOWS; the balancing act. Projects and groupdiscussions.

Motivation in real life: Recognize how motivation helps real life (Maslow‟s Theory); Leverage motivation in real-life scenarios; Scenario based activity on identifying and leveraging motivation.

Key Concepts-

i) **Pluralism & cultural spaces**: Identify pluralism in cultural spaces; Group activity for students to learn and exchange. Awareness and respect for pluralism in cultural spaces; Differentiate between the different cultures of India. Define and differentiate between global, glocal and translocational culture. Group activity on cultures in India.

ii) **Cross-cultural communication:** Recognize the implications of cross-cultural communication; identify the common mistakes made in cross-cultural communication. Apply cross cultural communication. Differentiate between the roles and relations of different genders.

i) **Science of Nation:** Role of science in nation building especially post-independence. Define AI (artificial intelligence) and recognize the importance of AI. Group activity on the role of scientists and mathematicians from ancient India.

Technical Writing Skills: Introduction to technical writing and basic rules of technical writing through examples. Practice activity on technical writing.

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

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

1. Apply & analyze the basic principles of SWOT; TOWS & life positions.
2. Understand, analyze & leverage the power of motivation in real life
3. Identify & respect pluralism in cultural spaces and apply the concepts of Global, glocal and translocational.
4. Analyze cross cultural communication and recognize common mistakes made in cross-cultural communication
5. Apply the science of Nation building and understand role of Artificial intelligence
6. Understand, apply & analyze the tools of technical writing

Web References:

1. Examples of Technical Writing for Students
   https://freelance-writing.lovetoknow.com/kinds-technical-writing
2. 11 Skills of a Good Technical Writer

https://clickhelp.com/clickhelp-technical-writing-blog/11-skills-of-a-good-technical-writer/

3. 13 benefits and challenges of cultural diversity in the workplace
   https://www.hult.edu/blog/benefits-challenges-cultural-diversity-workplace/

Online Resources:

1. https://youtu.be/CsaTslhSDI
2. https://m.youtube.com/watch?feature=youtu.be&v=IIKvV8_T95M
3. https://m.youtube.com/watch?feature=youtu.be&v=e80BbX05D7Y
4. https://m.youtube.com/watch?v=dT_D68RJ5T8&feature=youtu.be
5. https://m.youtube.com/watch?v=7sLLEdBgYYY&feature=youtu.be

UCT591: MINI PROJECT

L	T	P	Cr
-	-	-	1.0

Course Objectives: The objective of this mini project is to let the students apply the programming knowledge into a real-world situation/problem and exposed the students how programming skills helps in developing a good engineer. Mini 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, business ideas 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 3-4 students. Each group should select their team leader. 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, as per the time slot which will be provided to them by the respective supervisor. This is mandatory requirement for the fulfillment 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.

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

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

1. Develop skills necessary for structuring, managing, and executing the projects.
2. Design, develop, debug, document, and deliver a project and learn to work in a team environment.
3. Develop written and oral communication skills.
4. Become proficient with software development tools and environments.
5. Apply interdisciplinary knowledge to engineering design solutions, taking into account professional and ethical issues.

UCT511: COVERSATIONAL SYSTEMS

L	T	P	Cr
2	1	2	3.5

Course Objectives: The objective of the course is to enable attendees to acquire knowledge on chatbots and its terminologies. Work with ML Concepts and different algorithms to build custom ML Model. Better understand on Conversational experiences and provide better customer experiences.

Fundamentals of Conversational Systems:
Introduction: Overview, Case studies, Explanation about different modes of engagement for a human being, History and impact of AI Underlying technologies: Natural Language Processing, Artificial Intelligence and Machine Learning, NLG, Speech-To-Text, Text-To-Speech, Computer Vision etc. Introduction to Top players in Market – Google, MS, Amazon &Market trends Messaging Platforms (Facebook, WhatsApp) and Smart speakers – Alexa, Google Home and other new channels Ethical and Legal Considerations in AI Overview

Foundational Blocks for Programming Basic Python programming concepts, Node Basics Coding Best Practices Evaluation

Natural Language Processing:
Introduction: Brief history, Basic Concepts, Phases of NLP, Application of chatbotsetc General chatbot architecture, Basic concepts in chatbots: Intents, Entities, Utterances, Variables and Slots, Fulfillment Lexical Knowledge Networks (WordNet,Verbnet, PropBank, etc) Lexical Analysis, Part-of-Speech Tagging, Parsing/Syntactic analysis, Semantic Analysis, Word Sense Disambiguation. Information Extraction, Sentiment Analysis NLP using Python - Make use of any of the NLP libraries like NLTK, spaCy, Stanford NLP etc. (Practice session to use an NLP Tool -Hands on) Affective NLG.

Building a chatbot/Conversational AI Systems: Fundamentals of Conversational Systems (NLU, DM and NLG) Chatbot framework & Architecture, Conversational Flow & Design, Intent Classification (ML and DL based techniques), Dialogue Management Strategies, Natural Language Generation UX design, APIs and SDKs, Usage of Conversational Design Tools Introduction to popular chatbot frameworks – Google Dialog flow, Microsoft Bot Framework, Amazon Lex, RASA Channels: Facebook Messenger, Google Home, Alexa, WhatsApp, Custom Apps Overview of CE Testing techniques, A/B Testing, Introduction to Testing Frameworks -Botium /Mocha, Chai Security &Compliance – Data Management, Storage, GDPR, PCI, Building a Voice/Chat Bot - Hands on

Role of ML/AI in Conversational Technologies –Brief Understanding on how Conversational Systems uses ML technologies in ASR, NLP, Advanced Dialog management, Language Translation, Emotion/Sentiment Analysis, Information extraction ,etc. to effectively converse

Contact Centers: Introduction to Contact centers – Impact & Terminologies Case studies & Trends, How does a Virtual Agent/Assistant fit in here?

Overview on Conversational Analytics: Conversation Analytics: The need of it Introduction to Conversational Metrics

Future – Where are we headed? Summary, Robots and Sensory Applications overview**,** XR Technologies in Conversational Systems, XR-Commerce**,** What to expect next? – Future technologies and market innovations overview

Laboratory Work:

Project 1: Case Study to build a learning chatbot will ML based API like Amazon

Case Study to build a ML Model using LSTM/any RNN and integrate with chatbot

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

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

1. ML Concepts and different algorithms to build custom chatbot and conversational systems.
2. Comprehend the basics understanding of conversation environment.
3. Illustrate and apply the important features to describe a time series and perform simple analysis and computations on series.

Text Books:

1. Mactear, M. Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots (Synthesis Lectures on Human Language Technologies (2020).
2. Edward Loper, Ewan Klein, and Steven Bird Natural Language Processing with Python Book (2002), 8th ed.
3. The Elements of Statistical Learning: Data Mining, Inference, and Prediction Trevor Hastie, Robert Tibshirani, and Jerome Friedman (2003) 6th ed.
4. The Hundred-Page Machine Learning Book Andriy Burkov.

Reference Books:

1. Machine Learning Tom M. Mitchell, Wiley-Interscience (2006), 4th ed.
2. Natural Language Processing in Action: Understanding, Analyzing, and Generating Text with Python Book by Cole Howard, Hannes Hapke, and Hobson Lane.

UCT512: CLOUD, MICROSERVICES AND APPLICATION

L	T	P	Cr
2	1	2	3.5

Course Objectives: The course intends to introduce students to the fundamentals of developing application on Cloud, specifically public clouds such as AWS, AZURE and Google. Students would be able to appreciate:

1. How to design applications for Cloud
2. Develop applications using various services
3. Deploy applications on Cloud by using cloud native services

Cloud Fundamentals: Cloud Fundamentals, Models-IaaS/ PaaS / SaaS, NIST definition of Cloud, Cloud advantages deployment process. Public cloud Platform features-AWS, Azure, Google.

API Fundamentals Microservice fundamentals: Current system architecture, target system. Design approach. Design using spring boot project. examples. Sam Newman– Lectures on Micro services (references), API/Microservice design and deployment steps, Project use cases covering this

Devops fundamentals: Devops Tools and their usage in cloud application development, Docker and Containerization Process.

Python: Overview, Use cases for cloud application development.

Cloud Security and Monitoring Tools: Covering the cloud security and monitoring tools.

Tutorial Work: Design and developing solution steps using containers-containerization of application and deployment using Kubernetes, Projects use cases covering this.

Laboratory Work:
To select a cloud-based project and to design and implement applications on public cloud platforms such as AWS, AZURE and Google. To design use cases and implement cloud application using python.

Course Learning Outcomes (CLOs) / Course Objectives (COs):
After the completion of the course, the student will be able to:

1. Comprehend the basic concepts and architecture of Cloud computing.
2. Implement Cloud Services through AWS offerings and Restful web services.
3. Apply the knowledge of virtualization through different virtualization technologies.
4. Design use cases and implement Cloud-based project in python.

Text Books:

1. Buyya K, R., Broberg J. and Goscinski M. A., Cloud Computing: Principles and paradigms, MIT Press (2011) 4th ed. 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 McGraw Hill (2009) 1st ed.
2. Hurwitz J., Bllor R., Kaufman M. and Halper F., Cloud Computing for dummies (2009) 1st ed.

UCT513: MACHINE LEARNING

L	T	P	Cr
2	1	2	3.5

Course Objectives: This course provides a broad introduction to machine learning and statistical pattern recognition. It offers some of the most cost-effective approaches to automated knowledge acquisition in emerging data-rich disciplines and focuses on the theoretical understanding of these methods, as well as their computational implications.

Introduction to Machine Learning (ML); Relationship between ML and human learning, A quick survey of major models of how machines learn, Example applications of ML

Classification: Supervised Learning; The problem of classification, Feature engineering, Training and testing classifier models, Cross-validation, Model evaluation (precision, recall, F1-mesure, accuracy, area under curve), Statistical decision theory including discriminant functions and decision surfaces, Naive Bayes classification, Bayesian networks, Decision Tree and Random Forests, k-Nearest neighbor classification, Support Vector Machines, Artificial neural networks including backpropagation, Applications of classifications, Ensembles of classifiers including bagging and boosting.

Hidden Markov Models (HMM); HMM with forward-backward and Vierbi algorithms, Sequence classification using HMM, Conditional random fields, Applications of sequence classification such as part-of-speech tagging.

Regression: Multi-variable regression; Model evaluation, Least squares regression, Regularization, LASSO, Applications of regression.

Association rule mining: Association rule mining algorithms including apriori

Expectation-Maximization: EM algorithm for unsupervised learning, Clustering: average linkage; Ward‟s algorithm, Minimum spanning tree clustering, K-nearest neighbors clustering, BIRCH, CURE, DBSCAN

Anomaly and outlier detection methods

Laboratory Work:

Implement data preprocessing, Simple Linear Regression, Multiple Linear Regression, Decision Tree, Random forest classification, Naïve Bayes algorithm; K-Nearest Neighbors (K-NN), Support Vector Machine , k-Means, Apriori algorithm in Python.

Course Learning Outcomes (CLOs) / Course Objectives (COs):
After the completion of the course, the student will be able to:

1. Analyze methods and theories in the field of machine learning and provide an introduction to the basic principles, techniques, and applications of machine learning, supervised, unsupervised and reinforcement learning.
2. Comprehend and apply different classification and clustering techniques.
3. Comprehend and apply different association mining techniques.
4. Apply the algorithms to a real problem &optimize the models learned.

Text Books:

1. Mitchell M., T., Machine Learning, McGraw Hill (1997) 1st Edition.
2. Alpaydin E., Introduction to Machine Learning, MIT Press (2014) 3rd Edition.
3. Vijayvargia Abhishek, Machine Learning with Python, BPB Publication (2018).

Reference Books:

1. Bishop M., C., Pattern Recognition and Machine Learning, Springer-Verlag (2011) 2nd Edition.
2. Michie D., Spiegelhalter J. D., Taylor C. C., Campbell, J., Machine Learning, Neural and Statistical Classification. Overseas Press (1994).

UHU026: BEHAVIORAL ECONOMICS

L	T	P	Cr
3	0	2	4.0

Course Objectives: To impart knowledge on current ideas and concepts regarding decision making in Economics, particularly from a behavioral science perspective, which can affect choices and behavior of firms, households and other economics entities.

Introduction
The neoclassical/standard model and behavioral economics in contrast; historical background; behavioral economics and other social sciences; theory and evidence in the social sciences and in behavioral economics; applications – gains and losses, money illusion, charitable donation.

Basics of choice theory
Revisiting the neoclassical model; utility in economics and psychology; models of rationality; connections with evolutionary biology and cognitive neuroscience; policy analysis – consumption and addiction, environmental protection, retail therapy; applications – pricing, valuation, public goods, choice anomalies.

Beliefs, heuristics and biases
Revisiting rationality; causal aspects of irrationality; different kinds of biases and beliefs; self-evaluation and self-projection; inconsistent and biased beliefs; probability estimation; trading applications – trade in counterfeit goods, financial trading behavior, trade in memorabilia.

Choice under uncertainty
Background and expected utility theory; prospect theory and other theories; reference points; loss aversion; marginal utility; decision and probability weighting; applications – ownership and trade, income and consumption, performance in sports.

Intertemporal choice
Geometric discounting; preferences over time; anomalies of inter-temporal decisions; hyperbolic discounting; instantaneous utility; alternative concepts – future projection, mental accounts, heterogeneous selves, procedural choice; policy analysis – mobile calls, credit cards, organization of government; applications – consumption and savings, clubs and membership, consumption planning.

Strategic choice
Review of game theory and Nash equilibrium – strategies, information, equilibrium in pure and mixed strategies, iterated games, bargaining, signaling, learning; applications – competitive sports, bargaining and negotiation, monopoly and market entry.

Individual preferences; choice anomalies and inconsistencies; social preferences; altruism; fairness; reciprocity; trust; learning; communication; intention; demographic and cultural

aspects; social norms; compliance and punishment; inequity aversion; policy analysis – norms and markets, labor markets, market clearing, public goods; applications – logic and knowledge, voluntary contribution, compensation design.

Laboratory Work:
Case studies
Numerical Problems on Game Theory

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

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

1. Employ concepts from economics and psychology to gain a deeper understanding of individual behavior.
2. Demonstrate an understanding of traditional and modern microeconomic concepts and apply them for strategic decision making.
3. Apply rational choice theory to comprehend how heuristics can lead to systematic errors and biases in decision making.
4. Derive the behavior predicted by classical game theory in simple games.
5. Ability to apply behavioral models to interpret and predict behavior in simple frameworks.

Text Book:

1. An Introduction to Behavioral Economics, N. Wilkinson and M. Klaes, 2019.

Reference Book:

1. Holt, Charles A. Markets, Games, and Strategic Behavior: An Introduction to Experimental Economics. Princeton University Press, 2019.

UHU028: INDUSTRIAL PSYCHOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objectives: Introduces students to the content areas of industrial psychology and the application of psychological theory to organizational issues. Topics include employment law, job analysis, recruitment and selection, training, performance appraisal and discipline, employee motivation, and workplace safety. Using an applied approach, this course will help prepare students for their roles as employees and managers.

UNIT – I

What is I/O Psychology? Research Methods, Statistics, and Evidence-based Practice, Introduction & Legal Context of Industrial Psychology, Job Analysis & Competency Modeling, Job Evaluation & Compensation, Job Design & Employee Well-Being, Recruitment

UNIT – II

Identifying Criteria & Validating Tests and Measures, Screening Methods, Intensive Methods

UNIT – III

Performance Goals and Feedback, Performance Coaching and Evaluation, Evaluating Employee Performance

UNIT – IV

Employee Motivation, Satisfaction and Commitment, Fairness and Diversity

UNIT – V

Leadership, Organizational Climate, Culture, and Development, Teams in Organizations, The Organization of Work Behavior

UNIT – VI

Stress Management: Demands of Life and Work

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

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

1. Become conversant about the major content areas of Industrial Psychology i.e., job analysis, recruitment, selection, employment law.
2. Become conversant training, performance management, and health/well-being issues in the workplace.
3. Gain knowledge about involving job analysis, selection decisions, training programs, and employee well-being.
4. Prepare for other focused seminar courses in Industrial/Organizational Psychology or Human Resource Management.

Text Books:

1. Landy, F. J. and Conte, J. M. (2013). Work in the 21st Century (4th Edition). Oxford: Blackwell Publishing.

UCT601: COMPUTER NETWORKS

L	T	P	Cr
3	0	2	4.0

Course Objectives: To build the fundamental concepts of computer network, networking devices and various networking protocols.

Introduction: Computer networks and distributed systems, Classifications of computer networks, Preliminaries of layered network structures.

Data communication Components: Representation of data and its flow, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media.

LAN: Wired LAN, Wireless LAN, Virtual LAN.

Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.

Data Link Layer and Medium Access Sub Layer: Fundamentals of Error Detection and Error Correction, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go-back–N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols - Pure ALOHA, Slotted ALOHA, CSMA/CD, CDMA/CA.

Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols.

Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service (QoS), QoS improving techniques - Leaky Bucket and Token Bucket algorithms.

Application Layer: DNS, DDNS, TELNET, EMAIL, FTP, WWW, HTTP, SNMP, Bluetooth, Firewalls.

Network Security: Electronic mail, directory services and network management, Basic concepts of Cryptography.

Laboratory Work:
Network commands; ping, ipconfig/ifconfig, getmac, arp, hostname, tracert, netstat, nslookup, path ping etc. Working of various network layer protocols in an open source simulator.

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

1. Describe the basis and structure of an abstract layered protocol model.
2. Identify the different types of network devices and their functions within a network.

3. Comprehend and building the skills of subnetting and routing mechanisms.
4. Describe, analyse and evaluate a number of data link, network, and transport layer protocols.

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, Pearson (2017) 7th ed.
2. Stallings W., Computer Networking with Internet Protocols and Technology, Pearson (2004).

UCT602: INFORMATION SECURITY

L	T	P	Cr
3	0	2	4.0

Course Objectives: Learn the principles of information security to protect the confidentiality, integrity, and availability of information. Discuss the modes of threats and attacks on information systems, threat mitigation, cryptography, user identification and authentication, access control, privacy laws, and more.

Overview of Security Parameters: Confidentiality, integrity and availability; Security violation and threats; Security policy and procedure; Assumptions and Trust; Security Assurance, Implementation and Operational Issues; Security Life Cycle.

Access Control Models: Discretionary, mandatory, roll-based and task-based models, unified models, access control algebra, temporal and spatio-temporal models.

Security Policies: Confidentiality policies, integrity policies, hybrid policies, non-interference and policy composition, international standards.

Systems Design: Design principles, representing identity, control of access and information flow, confinement problem. Assurance: Building systems with assurance, formal methods, evaluating systems.

Logic-based System: Malicious logic, vulnerability analysis, auditing, intrusion detection. Applications: Network security, operating system security, user security, program security.

Special Topics: Data privacy, introduction to digital forensics, enterprise security specification.

Operating Systems Security: Security Architecture, Analysis of Security in Linux/Windows.

Database Security: Security Architecture, Enterprise security, Database auditing.

Laboratory Work:

1. Analysis of security in Unix/Linux.
2. Administration of users, password policies, privileges and roles

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

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

1. Understand the technical, social & political aspects of Information and its applications.
2. Analyze the vulnerabilities and threats with respect to various types of attacks.
3. Understand the access control systems and their applicability in wide range of applications.

4. Recognize the attacks and defense patterns during information processing and management.

Text Books:

1. Security Engineering, Ross Anderson.
2. Computer Security: Art and Science, M. Bishop, Pearson Education.
3. Information Security: Principles and Practice, M. Stamp.

Reference Books:

3. Security in Computing, C.P. Pfleeger, S.L. Pfleeger, J. Margulies.
4. Secure Programming HOWTO, David Wheeler.
5. Browser Security Handbook, Michael Zalewski.
6. Handbook of Database Security, M. Gertz, S. Jajodia.

UCT603: Artificial Intelligence

L	T	P	Cr
3	0	2	4.0

Course Objectives: To be familiar with the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, knowledge acquisition and learning methods in solving particular engineering problems.

Introduction, Overview of Artificial intelligence: Problems of AI, AI technique, Tic - Tac - Toe problem. Intelligent Agents, Agents & environment, nature of environment, structure of agents, goal based agents, utility based agents, learning agents.

Problem Solving, Problems, Problem Space & search: Defining the problem as state space search, production system, problem characteristics, issues in the design of search programs.

Search techniques: Problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies. Heuristic search strategies Greedy best-first search, A* search, AO* search, memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search.

Constraint satisfaction problems: Local search for constraint satisfaction problems. Adversarial search, Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening.

Knowledge & reasoning: Knowledge representation issues, representation & mapping, approaches to knowledge representation. Using predicate logic, representing simple fact in logic, representing instant & ISA relationship, computable functions & predicates, resolution, natural deduction. Representing knowledge using rules, Procedural verses declarative knowledge, logic programming, forward verses backward reasoning, matching, control knowledge.

Probabilistic reasoning: Representing knowledge in an uncertain domain, the semantics of Bayesian networks, Dempster-Shafer theory, Planning Overview, components of a planning system, Goal stack planning, Hierarchical planning, other planning techniques.

Expert Systems: Representing and using domain knowledge, expert system shells, and knowledge acquisition.

Laboratory Work:
Programming in Python: Programs for Search algorithms like heuristics, optimal search, and graph heuristics, Constraint satisfaction problems, k-nearest neighbors, decision trees, etc.

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

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

1. Learn the basics and applications of artificial intelligence and categorize various problem domains, basic knowledge representation and reasoning methods.
2. Analyze basic and advanced search techniques including game playing,constraint satisfaction.
3. Learn and design intelligent agents for concrete computational problems.
4. Understand and implement the basic concepts of programming languages like Prolog.
5. Acquire knowledge about the architecture of an expert system and design new expert systems for real life applications.

Text Books:

1. Rich E., Knight K. and Nair B. S., Artificial Intelligence, Tata McGraw Hills (2009) 3rd ed.
2. Luger F. G., Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education Asia (2009) 6th ed.

Reference Books:

1. Patterson W. D., Introduction to Artificial Intelligence and Expert Systems, Pearson (2015) 1st ed.
2. Russel S., Norvig P., Artificial Intelligence: A Modern Approach, Prentice Hall (2014) 3rd ed.

UHU043: FINANCIAL & COST ACCOUNTING

L	T	P	Cr
2	0	0	2.0

Course Objectives: The main goal of financial accounting is to create the financial statements which are useful to the external parties/various stakeholders in measuring the financial wellbeing of the businesses. Understanding these reported financial statements develops the students' ability to assess managerial performance and financial soundness of the businesses for financial decision-making at local and global level. The course will also consider the several subject areas from cost accounting: product costing and cost behaviours, budgeting, flexible budgets and performance analysis, process and unit costing and marginal costing. The course aims to

1. Develop a basic understanding of accounting concepts.
2. Develop skills to comment on the financial health of the organisation.
3. Understand how accounting information is used to make and communicate management decisions needed to run the entity.
4. To enable students to classify costs and prepare Cost Sheet.
5. Develop understanding about the different budgets as required for controlling the business operation.
6. Develop understanding about the critical managerial decision using different techniques and principles of Process Costing, ABC Analysis and Marginal costing

Accounting Concept: Introduction, Techniques and Conventions, Financial Statements-Understanding & Interpreting Financial Statements

Accounting Process: Book Keeping and Record Maintenance, Fundamental Principles and Double Entry**,** Journal, Ledger, Trial Balance, Balance Sheet, Final Accounts**,** Cash Book and Subsidiary Books**,** Rectification of Errors

Financial Statements: Form and Contents of Financial Statements, Analyzing and Interpreting Financial Statements, Accounting Standards.
Class Discussion: Corporate Accounting Fraud- A Case Study of Satyam

Cash Flow and Fund Flow Techniques: Introduction, How to prepare, Difference between them

Costing Systems: Elements of Cost**,** Cost Behavior, Cost Allocation, OH Allocation**,** Unit Costing, Process Costing, Job Costing**,** Absorption Costing, Marginal Costing, Cost Volume Profit Analysis**,** Budgets**,** ABC Analysis.
Class Discussion: Application of costing concepts in the Service Sector

Company Accounts and Annual Reports: Audit Reports and Statutory Requirements**,** Directors Report**,** Notes to Accounts**,** Pitfalls

Home Assignment:

Case study materials book will be given to students. Students are required to meet in groups before coming to class and prepare on the case for the day. Instructor may ask the student groups to present their analysis and findings to the class.

Further, the topic for class discussion will be mentioned beforehand and students should be prepared to discuss these topics in class. Few topics are mentioned below as examples. Instructor can add or change any topic as per requirement.

1. Topic: Corporate Accounting Fraud: A Case Study of Satyam
2. Topic: Application of costing concepts in the Service Sector

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

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

1. To create awareness about the importance and usefulness of the accounting concepts and their managerial implications.
2. To develop an understanding of the financial statements and the underlying principles and learn to interpret financial statements.
3. Develop the ability to evaluate, communicate, analyze and interpret the financial results of businesses for financial decision-making.
4. To create awareness about cost accounting, different types of costing and cost management.
5. Ability to take critical managerial decision using different techniques and principles of Marginal costing and Standard Costing.

Text Books:

1. Robert N Anthony, David Hawkins, Kenneth Marchant, *Accounting: Texts and Cases*, McGraw-Hill
2. Nigam, B.M. Lall and I.C. Jain, Cost Accounting, Principles and Practice, Prentice Hall of India, New Delhi.
3. Drury, Colin, Management and Cost Accounting, Thomson Learning.
4. Case Study Materials: To be distributed for class discussion.

Reference Books:

1. Anthony, R. N., Hawkins, D. F. and Merchant, K. A. (2013). *Accounting: Text & Cases (13th ed.)*. New Delhi, India: McGraw Hill.
2. Godwin, N.H., Alderman, C.W. and Sanyal, D. (2012). *An Innovative Approach to Learning and Teaching-Financial Accounting (1st ed.)*. New Delhi, India: Cengage Learning.
3. Lal, Jawahar and Seema Srivastava, Cost Accounting, McGraw Hill Publishing Co., New Delhi
4. Usry, Milton E. and Lawrence H. Hammer, Cost Accounting, Planning and Control, South Western Publishing Co.

UHU044: BUSINESS COMMUNICATION & VALUE SCIENCE-IV

L	T	P	Cr
2	0	2	3.0

Course Objectives: To apply communicative writing in real life scenarios; to identify the best practices of public speaking; recognizing the business idioms and corporate terms. Understand emotional intelligence in personal and professional lives. Impact of conflicts and stress on life & work and stress management. Recognize the importance of locus of control and to share and receive feedback. Practice time management; diversity in workplace and CSR.

Communicative Writing: Identify the key aspects of communicative writing; Apply communicative writing in real life scenarios; Using charts and graphs in communicative writing; Formal and Business letters; Proposal writing; telling a story with charts and graphs. Group activities and videos.

Public Speaking: Understand the need of public speaking at your workplace; identify the best practices of public speaking; Apply public speaking in real life scenarios; Recognize and apply the business idioms and corporate terms. Practice public speaking and pitch a start-up idea. Quiz on business idioms and corporate terms.

Emotional Intelligence: Introduce concept of EI; Importance of EI in personal and professional lives; Applying EI. Games and activities for applying Emotional Intelligence using scenarios and their analysis.

Impact of conflicts and stress on life & work: Understanding conflicts and tips to manage conflicts; Managing Stress and identify the best practices to manage stress. Reflection on lessons in empathy and active listening while managing conflicts, Videos and Poster presentation.

Feedback; Time Management; CSR: Recognize the importance of giving and receiving feedback; Importance of locus of control; Identify the best time management practices; understand the importance of diversity in workplace; recognize the importance of corporate social responsibility (CSR). Open house discussions, role plays, CSR stories and reference material.

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

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

1. Apply the best practices of communicative writing
2. Identify the best practices of public speaking
3. Understand the importance of emotional intelligence in personal and professional lives
4. Use the basic guidelines required to manage conflicts and stress
5. Recognize importance of feedback and identify the best time management practices
6. Understand the importance diversity in workplace and corporate social responsibility (CSR)

Text Books: There are no prescribed texts; there will be handouts and reference links shared.

Reference Books:

1. Emotional Intelligence: Why it can Matter More Than IQ by Daniel Goleman
2. Putting Emotional Intelligence to Work by Ryback David
3. How to Develop Self Confidence and Improve Public Speaking - Time - Tested Methods of Persuasion by Dale Carnegie
4. TED Talks: The official TED guide to public speaking: Tips and tricks for giving unforgettable speeches and presentations

Web References:

1. https://www.tata.com/about-us/tata-group-our-heritage
2. https://economictimes.indiatimes.com/tata-success-story-is-based-on humanityphilanthropy-and-ethics/articleshow/41766592.cms

Online Resources:

1. https://youtu.be/reu8rzD6ZAE
2. https://youtu.be/Wx9v_J34Fyo
3. https://youtu.be/F2hc2FLOdhI
4. https://youtu.be/wHGqp8lz36c
5. https://youtu.be/hxS5He3KVEM
6. https://youtu.be/nMPqsjuXDmE

UCT632: Modern Web Applications

L	T	P	Cr
3	0	2	4.0

Course Objectives: To provide an understanding of various modern programming languages such as HTML, CSS, JavaScript, XML, PHP and MySQL for the Web development.

Introduction to Internet & World Wide Web: History of the Internet & World- Wide Web, Web Browsers, Web Servers, Uniform Resource Locator, Tools and Web Programming Languages, Web Standards, Categories of Web Applications, Characteristics of Web Applications, Tiered Architecture.

Hypertext Mark Up Language: Basic HTML page, Text Formatting, Table, Headers, Linking, Images, List, Meta Elements.

Cascading Style Sheets (CSS): Inline, Internal and External Style Sheet, Bootstrap- CSS Text, CSS forms, CSS components drop down.

Java Script: Introduction to Java Scripts, Objects in Java Script, Dynamic HTML with Java Script, Bootstrap- JS Alert, JS Button, JS popover.

Extensible Markup Language (XML): Introduction, Structuring Data, Document Type Definition, XML Vocabularies, Document Object Model (DOM) with JavaScript, Extensible Styles sheet Language Transforms (XSL).

Writing Basic PHP Programs: Creating PHP Programs, Numbers and Strings, Literals Variables, Operators and Functions.

Form & PHP: Creating Form Controls, Using Values Returned From, Forms Using PHP

PHP Database Connectivity: Connecting to MySQL Server, Selecting Databases, Checking for Errors, Closing the MySQL Server Connection Manipulating Data in MySQL Using PHP: Inserting, Viewing, Updating and Deleting Records, Manipulating joined tables.

User Authentication: Creating Session, Authorization Level

Laboratory Work:
Use of tags in HTML ,Creating and designing Form , Applying Style rules with CSS, Positioning and Layout in CSS, JavaScript Variables, Operators, Array, Strings and Functions ,Objects in Java Script, XML and DOM, Event Handling with PHP, Creating and Manipulating Data in MySQL.

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

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

1. Comprehend the concept of the Web Server, Web Browser, URL and usage of Web Programming Languages for the Web development.
2. Illustrate the usage of tags and style rules in designing or styling of the Web Pages through HTML and CSS.
3. Analyze the role of XML and JavaScript in creating the interactive web pages on the Internet.
4. Understand the need of Server Side Scripting Language PHP and MYSQL Databases in the development of the Web Applications.

Text Books:

1. Deitel P. J., Deitel H. M. and Deitel A. (2012) Internet and World Wide Web: How to Program, 5th Edition, Pearson Prentice Hall.
2. HTML & CSS: Design and Build Websites, Jon Duckett, John Wiley & Sons.
3. Naramore E., Gerner J., Scouarnec Y.L., et al., (2005) Beginning PHP5, Apache, MySQL Web Development: Programmer to Programmer, John Wiley & Sons Inc.

Reference Books:

1. Sebesta R. W. (2014) Programming the World Wide Web, 8th edition, Pearson.
2. Pressman R. and Lowe D. (2008) Web Engineering: a practitioner's approach, 1st Edition, McGraw Hill.
3. Kappel G., et al. (2006) Web Engineering: The Discipline of systematic Development of Web Applications, 1st Edition, John Wiley & Sons.
4. Suh W. (2005) Web Engineering: Principles and Techniques, Idea Group Inc.
5. Ullman L (2016) PHP for the Web: Visual Quick Start Guide, 5th Edition, Peachpit Press.

UCT633: DATA MINING AND ANALYTICS

L	T	P	Cr
3	0	2	4.0

Course Objectives: To provide an understanding of various data mining and statistical analysis algorithms such as correlation analysis, regression, classification, estimation, time-series analysis and forecasting.

Introduction to Data Mining: What is data mining? Related technologies - Machine Learning, DBMS, OLAP, Statistics, Stages of the Data Mining Process, Data Mining Techniques, Knowledge Representation Methods, Applications

Data preprocessing: Data cleaning, Data transformation, Data reduction, Discretization and generating concept hierarchies, Installing Weka, Data Mining System, Experiments with Weka - filters, discretization

Data mining knowledge representation: Task relevant data, Background knowledge, Representing input data and output knowledge, Visualization techniques

Attribute-oriented analysis: Attribute generalization, Attribute relevance, Class comparison, Statistical measures

Data mining algorithms - Association rules: Motivation and terminology, Example: mining weather data, Basic idea: item sets, Generating item sets and rules efficiently, Correlation analysis

Data mining algorithms - Classification: Basic learning/mining tasks, Inferring rudimentary rules: 1R, algorithm, Decision trees, covering rules

Data mining algorithms – Prediction: The prediction task, Statistical (Bayesian) classification, Bayesian networks, Instance-based methods (nearest neighbor), linear models

Descriptive analytics: Data Modeling, Trend Analysis, Simple Linear Regression Analysis

Forecasting models: Heuristic methods, predictive modelling and pattern discovery, Logistic Regression: Logit transform, ML estimation, Tests of hypotheses, Wald test, LR test, score test, test for overall regression, multiple logistic regression, forward, backward method, interpretation of parameters, relation with categorical data analysis. Interpreting Regression Models, Implementing Predictive Models

Generalized Linear model: link functions such as Poisson, binomial, inverse binomial, inverse Gaussian, Gamma.

Non Linear Regression (NLS): Linearization transforms, their uses & limitations, examination of non-linearity, initial estimates, iterative procedures for NLS, grid search, Newton-Raphson, steepest descent, Marquardt‟s methods. Introduction to semi parametric regression models, additive regression models. Introduction to nonparametric regression methods

Time Series Analysis: Auto - Covariance, Auto-correlation and their properties. Exploratory time series analysis, Test for trend and seasonality, Exponential and moving average smoothing, Holt – Winter smoothing, forecasting based on smoothing

Linear time series models: Autoregressive, Moving Average, Autoregressive Moving Average and Autoregressive Integrated Moving Average models; Estimation of ARMA models such as Yule-Walker estimation for AR Processes, Maximum likelihood and least squares estimation for ARMA Processes, Forecasting using ARIMA models

Prescriptive Analytics: Mathematical optimization, Networks modelling-Multi-objective optimization-Stochastic modelling, Decision and Risk analysis, Decision trees.

Laboratory Work:

To implement various data mining techniques studied during the course using Python/Weka tool.

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

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

1. Learn the basic concepts of data mining and its applications in different domains such as finance, utility, agriculture etc.
2. Learn and understand the basics of data analysis and processing, including preprocessing, representation and modelling techniques.
3. Understand and apply different supervised data mining algorithms, including association rules mining, classification and prediction.
4. Comprehend the basics of linear and non-linear regression models.
5. Understand and implement basics of time-series analysis and related prediction models.

Text Books:

1. Jiawei Han and Micheline Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, 3rd ed, 2010.
2. Lior Rokach and Oded Maimon, "Data Mining and Knowledge Discovery Handbook", Springer, 2nd edition, 2010
3. Box, G.E.P and Jenkins G.M. (1970) Time Series Analysis, Forecasting and Control, Holden-Day.

Reference Books:

1. Draper, N. R. and Smith, H. (1998). Applied Regression Analysis (John Wiley) Third Edition.
2. Hosmer, D. W. and Lemeshow, S. (1989). Applied Logistic Regression (Wiley).

UCT642: ENTERPRISE SYSTEMS

L	T	P	Cr
2	0	2	3.0

Course Objectives: To provide an understanding of skills in understanding architecture and non-functional requirements in developing Enterprise system development and their deployment.

Introduction to Modern Enterprise Systems: Introduction to enterprise systems. Elements of enterprise systems – Business Information system, Decision support systems, Knowledge management systems, Financial and human resource systems. Kinds of Enterprise systems- B2C and B2B models.
Components of Enterprise systems: Channels (Mobile, web, desktop, partner integration), Data management, workflow, Controlling and Auditing, Accounting etc.
Sample Enterprise systems: ERP, SCM, CRM, Product Life cycle management (PLM), HR Systems (HRM), GL systems.

Key characteristics Enterprise systems: Distributivity, Managed redundancy, Exception processing, Collaboration, Data transformation.
Enterprise System architectures: Batch processing, Monolithic, client server, ecommerce, service oriented, microservice, and cloud architectures.

Introduction to Enterprise Application architectures: Layer Architecture, Event driven Architecture, Service oriented Architecture, Microservice architecture, Plug-in architecture
Application architecture Patterns: Layering, Organizing domain logic, Mapping to database, Web Presentation, Concurrency.

Enterprise Application Integration: Introduction to Enterprise Integration, different integration styles. Elements of messaging-based Integration.
Enterprise Integration patterns: Modern service integration techniques. Introduction to WSDL, SOAP. Introduction Restful webservices integration. Differences between SOAP and REST.

Deployment of Enterprise applications: Key requirements in deployment - Stability, capacity, Security, availability, Network, Availability, and Transparency

Concepts of Cloud computing, cloud platforms and their role in Enterprise systems: Core Concepts – Types of Cloud: Private, public, and Hybrid clouds. Advantage of cloud computing – Scaling, Availability, and cost. Disadvantages – Technology overload, Security, Monitoring and troubleshooting, Testing, Latency etc. Cloud service models: - Infrastructure, platform, Software as a Service in Cloud Computing. Major public clouds: Google cloud, AWS, Azure.
Application development and deployment in cloud – Dockers, micro services, Kubernetes, Serverless. Continuous Integration/Continuous Delivery

Introduction to Enterprise Architecture: Importance of Enterprise Architecture. Enterprise architecture models. Zachman Framework, TOGAF Framework

Laboratory Work

Identify an open-source application and ask students to study/develop/modify various elements of the application from enterprise systems architecture, development and deployment perspective. Enterprise Architecture Case studies.

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

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

1. Understand basic elements of Enterprise systems
2. Develop skills in understanding architecture and non-functional requirements in developing Enterprise system development and their deployment
3. Understand the modern Enterprise Systems.
4. Comprehend the concepts of cloud computing in Enterprise Systems
5. Illustration of requirements to design an Enterprise Application using Open-source tools.
6. To develop critical thinking for the understanding of success and failures of Enterprise adoption by various organizations
7. Understand future trends in Enterprise architectures.

Text Books:

1. Ralph Stair, George Reynold, "Principle of Information Systems", 10th edition.
2. Martin Fowler et al, "Pattern of Enterprise Application Architecture", Addison-Wesley, 2012
3. Gregor Hohpe, Bobby Woolf, Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions,
4. Mark Richards, Software Architecture patterns, 2015, O"Reilly.
5. Sam Newman, "Building Microservices", 2015, O"Reilly.
6. David Farley, Jez Humble, "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation", Jan 2016

Reference Books:

1. Brendan Burns, Designing Distributed Systems, O"Reilly, 2016
2. Enterprise Integration Patterns - Messaging Patterns Overview
3. Software architecture in Practice 3rd Edition- 2014

UHU046: Advance Finance

L	T	P	Cr
2	0	2	3.0

Course Objectives: The various objectives of the course are:

1. To understand the various sources of financing and valuations of equity and debts
2. To develop the understanding of various dividend decisions theories and practices
3. Evaluation of lease financing and decisions
4. Develop capabilities for working capital management
5. Apply corporate restructuring and financial restructuring for financial decisions

Sources of Funds: Types of securities, Issuing the capital in market, Pricing of issue, Valuation of Stocks and bonds

Dividend Decisions: Traditional Approach, Dividend Relevance Model, Miller and Modigliani Model, Stability of Dividends, Forms of Dividends, Issue of bonus shares, Stock Split

Evaluation of Lease Contracts: Leasing, Types of leasing, leasing agreements, evaluating the lease decisions

Corporate Restructuring: Mergers and Acquisitions- Types of Mergers, Evaluation of Merger Proposal, Take-over, Amalgamation, Leverage buy-out, Management buy-out, Corporate Failure and Liquidation

Financial Restructuring: Share Split, Consolidation, Cancellation of Paid-up Capital, Other Mechanisms

Working Capital Management: Working Capital Planning, Monitoring and Control of Working Capital, Working Capital Financing, Managing the Components of Working Capital-Cash Management, Receivable Management, and Inventory Management

Introduction to Derivatives: Basics of Futures, Forwards, Options, Swaps, Interest rate Payoff Diagrams, Pricing of Futures, Put Call Parity, Option Pricing using Binomial Model and Black Scholes Model, Use of Derivatives for Risk-Return Management- Credit Default Swaps

Home Assignment:

Case study materials book will be given to students. Students are required to meet in groups before coming to class and prepare on the case for the day. Instructor may ask the student groups to present their analysis and findings to the class.

Further, the topic for class discussion will be mentioned beforehand and students should be prepared to discuss these topics in class. Few topics are mentioned below as examples. Instructor can add or change any topic as per requirement.

1. Topic: Historical perspectives of markets like major boom and busts, bull and bear cycles, major market crashes, bubbles
2. Topic: Major scams in the market, e.g. Satyam case

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

This course will help students to develop in-depth knowledge about the financial techniques and instruments. The students will learn to

1. Imbibe knowledge about the decisions and decision variables involved with financial activities of the firm.
2. Develop skills for interpretation business information and application of financial theory in corporate investment decisions, with special emphasis on working capital management.
3. Familiarizing the students with the corporate and financial restructuring.

Text Books:

1. Khan M.Y., and Jain, P.K., Financial Management: Text, Problems, and Cases, Tata McGraw Hill (2008), 5th Edition, New Delhi.

Reference Books:

1. Booth, L., Cleary, W.S., and Drake, P.P., Corporate Finance, Wiley India Edition (2014), New Delhi.

UCT641: IMAGE RECOGNITION AND PATTERN RECOGNITION

L	T	P	Cr
2	0	2	3.0

Course Objectives: To provide the understanding the concepts of image processing and basic analytical methods to be used in various image processing techniques such as enhancement, segmentation, and recognition.

Introduction: Image processing systems and its applications. Basic image file formats.

Image formation: Geometric and photometric models; Digitization - sampling, quantization; Image definition and its representation, neighbourhood metrics.

Intensity transformations and spatial filtering: Enhancement, contrast stretching, histogram specification, local contrast enhancement; Smoothing, linear and order statistic filtering, sharpening, spatial convolution, Gaussian smoothing, DoG, LoG.

Segmentation: Pixel classification; Grey level thresholding, global/local thresholding; Optimum thresholding - Bayes analysis, Otsu method; Derivative based edge detection operators, edge detection/linking, Canny edge detector; Region growing, split/merge techniques, line detection, Hough transform.

Image/Object features extraction: Textural features - gray level co-occurrence matrix; Moments; Connected component analysis; Convex hull; Distance transform, medial axis transform, skeletonization/thinning, shape properties.

Registration: Mono-modal/multimodal image registration; Global/local registration; Transform and similarity measures for registration; Intensity/pixel interpolation.

Colour image processing: Fundamentals of different colour models - RGB, CMY, HSI, YCbCr, Lab; False colour; Pseudo colour; Enhancement; Segmentation.

Morphological Filtering Basics: Dilation and Erosion Operators, Top Hat Filters

Laboratory Work

To implement various image processing techniques studied during the course using OpenCV/MATLAB.

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

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

1. Learn the fundamentals of digital image formation and its processing along with its practical applications in various domains.
2. Understand and perform the various image enhancement techniques in spatial and frequency domain.

3. Learn and apply the concept of image segmentation.
4. Understand and implement feature extraction techniques for object detection and recognition
5. Elucidate the mathematical modelling of image registration and morphological filters.
6. Understand the various color models and comprehend the enhancement and segmentation techniques for the same.

Text Books:

1. Digital Image Processing. R. C. Gonzalez and R. E. Woods, Prentice Hall.

Reference Books:

1. Image Processing: The Fundamentals. Maria Petrou and Panagiota Bosdogianni, John Wiley & Sons, Ltd.
2. Digital Image Processing. K. R. Castleman:, Prentice Hall, Englewood Cliffs.
3. Visual Reconstruction. A. Blake and A. Zisserman, MIT Press, Cambridge.
4. Digital Pictures. A. N. Netravali and B. G. Haskell, Plenum Press.
5. Digital Images and Human Vision. A. B. Watson: MIT Press, Cambridge.

UCT701: USABILITY DESIGN OF SOFTWARE APPLICATIONS

L	T	P	Cr
2	0	2	3.0

Course Objectives: The major emphasis of the course will be on creating a learning system through which management students can enhance their innovation and creative thinking skills, acquaint themselves with the special challenges of starting new ventures and use IPR as an effective tool to protect their innovations and intangible assets from exploitation.

Introduction to User Centred Design

Aspects of User Centred Design: Product Appreciation Assignment – Evaluating the product from user centred design aspects such as functionality, ease of use, ergonomics, aesthetics.

Heuristic Evaluation: 10 Heuristic Principles, Examples Heuristic Evaluation: Group Assignment initiation (Website and App), Evaluation for key tasks of the app or website for heuristic principles, severity, recommendations.

Group Assignment Presentations and reviews

Group Project identification: Students will identify a project such as a website or mobile app to redesign. They will take this redesign project through the design lifecycle:

- Discovery
- Define
- Design
- Implement (Design Prototype)
- Usability Testing

The below design methods and techniques will be imparted w.r.t. the group project selected by the students.

UX Research: Understanding users, their goals, context of use, and environment of use.

Research Techniques: Contextual Enquiry, User Interviews, Competitive Analysis for UX.

Scenarios and Persona Technique

Presentation of Personas for the group project

Design Thinking Technique
Discovery and brainstorming

Concept Development

Task flow detailing for the Project

Prototyping Techniques: Paper, Electronic, Prototyping Tools

Project Prototyping Iteration 1

Project Prototyping Iteration 2

Review and feedback

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

1. To sensitise the students to the fundamentals of User Centred Design, its relevance and contribution to businesses.
2. To familiarize them with heuristic principles for effective design of software applications.
3. To understand the user research methods for a better user experience.
4. To acquire knowledge in redesigning an existing application or website.

Text Books:

1. Class Handouts
2. Online forum links, reference articles, blogs
3. Interaction Design: Beyond Human-Computer Interaction, 4th Edition, Jenny Preece, Helen Sharp and Yvonne Rogers
4. About Face, 4th Edition, Alan Cooper and Robert Reimann
5. Observing the User Experience, Second Edition: A Practitioner's Guide to User Research. Elizabeth Goodman, Mike Kuniavsky, Andrea Moed
6. The Elements of User Experience: User-Centered Design for the Web and Beyond. 2nd Edition, Jesse James Garrett
7. Understanding Design Thinking, Lean, and Agile - Jonny Schneider

UCT702: IT Workshop Skylab/ MATLAB

L	T	P	Cr
1	0	2	2.0

Course Objectives: To provide an understanding of programming concepts and skills needed for basic problem solving using MATLAB, along with specific focus on image processing algorithms.

Introduction to MATLAB
History, basic features, strengths and weaknesses, good programming practices and plan your code.

Working with variables, workspace and miscellaneous commands
Creating variables, overwriting variable, error messages, making corrections, controlling the hierarchy of operations or precedence, controlling the appearance of floating point number, managing the workspace, keeping track of your work session, entering multiple statements per line, miscellaneous commands.

Matrix, array and basic mathematical functions
Matrix generation, entering a vector, entering a matrix, matrix indexing, colon operator, linear spacing, creating a sub-matrix, dimension, matrix operations and functions matrix generators, special matrices, array and array operations, solving linear equations, other mathematical functions.

Basic plotting
Overview, creating simple plots, adding titles, axis labels, and annotations, multiple data sets in one plot, specifying line styles and colours.

Introduction to programming
Introduction, M-File Scripts, script side-effects, M-File functions, anatomy of a M-File function, input and output arguments, input to a script file, output commands.

Control flow and operators
``if ... end" structure, relational and logical operators, ``for ... end" loop, ``while ... end" loop, other flow structures, operator precedence, saving output to a file.

Debugging M-files
Debugging process, preparing for debugging, setting breakpoints, running with breakpoints, examining values, correcting and ending debugging, correcting an M-file.

Laboratory
Implementation of various Image Processing Algorithms.

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

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

1. Understand the fundamental programming concepts in MATLAB such as variables, data types, control structures, operators, workspace etc.
2. Comprehend the use of matrix, array and basic mathematical functions for problem solving.
3. Understand and implement the M-file scripts and functions.
4. Illustrate and implement various image processing techniques.

Text Books:

1. Gonzalez R. C., Woods R. E., Eddins S. L. , Digital Image Processing using MATLAB, Pearson Education India (2004), 2nd ed.
2. Attaway S., MATLAB: A Practical Introduction to Programming and Problem Solving, Butterworth-Heinemann (2017), 4th ed.

Reference Books:

1. https://www.mathworks.com/content/dam/mathworks/mathworks-dot-com/moler/exm/book.pdf
2. https://www.mathworks.com/help/releases/R2014b/pdf_doc/matlab/getstart.pdf

UHU047: FINANCIAL MANAGEMENT

L	T	P	Cr
2	1	0	2.5

Course Objectives:

1. Give an in-depth view of the process in financial management of the firm.
2. Improving students‟ understanding of the time value of money concept and the role of a financial manager in the current competitive business scenario.
3. Understanding of basic concepts such as time value of money cost of capital, risk and return, capital budgeting etc.
4. Enhancing student‟s ability in dealing short-term dealing with day-to-day working capital decision; and also longer-term dealing, which involves major capital investment decisions and raising long-term finance.

Introduction: Introduction to Financial Management - Goals of the firm - Financial Environments.

Time Value of Money: Simple and Compound Interest Rates, Amortization, Computing more that once a year, Annuity Factor.

Valuation of Securities: Bond Valuation, Preferred Stock Valuation , Common Stock Valuation, Concept of Yield and YTM.

Risk & Return: Defining Risk and Return, Using Probability Distributions to Measure Risk, Attitudes Toward Risk, Risk and Return in a Portfolio Context, Diversification, The Capital Asset Pricing Model (CAPM)

Operating & Financial Leverage: Operating Leverage, Financial Leverage, Total Leverage, Indifference Analysis in leverage study

Cost of Capital : Concept , Computation of Specific Cost of Capital for Equity - Preference – Debt, Weighted Average Cost of Capital – Factors affecting Cost of Capital 4L

Capital Budgeting : The Capital Budgeting Concept & Process - An Overview, Generating Investment Project Proposals, Estimating Project, After Tax Incremental Operating Cash Flows, Capital Budgeting Techniques, Project Evaluation and Selection - Alternative Methods

Working Capital Management: Overview, Working Capital Issues, Financing Current Assets (Short Term and Long Term- Mix), Combining Liability Structures and Current Asset Decisions, Estimation of Working Capital.

Cash Management: Motives for Holding cash, Speeding Up Cash Receipts, Slowing Down Cash Payouts, Electronic Commerce, Outsourcing, Cash Balances to maintain, Factoring.

Accounts Receivable Management: Credit & Collection Policies, Analyzing the Credit Applicant, Credit References, Selecting optimum Credit period. 4L

Tutorial Work:

Financial Modelling using Excel, Case study, Solving tutorial sheets of numerical problems related to Time value of money, securities valuation, Leverage, Cost of Capital, capital budgeting etc.

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

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

1. Improving students‟ understanding of the time value of money concept and the role of a financial manager in the current competitive business scenario.
2. Apply the methods and procedures for the valuation of bonds and equity share capital.
3. Apply the methods and procedures of financial management, with particular reference to investment evaluation, investment management, capital budgeting, risk management.
4. Estimate a company‟s cost of capital; determine whether a company is creating or destroying value; select a company‟s optimal mix of debt and equity financing; and compensate shareholders in the most convenient way.
5. Students‟ ability to deal with different issues of working capital management, financing of short term assets and cash management.

Text Books:

1. Pandey, I. M., Financial management, Vikas Publishing House Pvt. Ltd., Noida, 2011, 12th ed.
2. Chandra, Prasanna - Financial Management - Theory & Practice, Tata McGraw Hill.
3. Brigham. Eugene F. and Houston. Joel F. (2006). Fundamentals of Financial Management, 10th Edition, Cengage Learning
4. Khan, M.Y & Jain, P.K.: Financial Management; Tata McGraw Hill, New Delhi, 2008.

References Books:

1. Srivastava, Misra: Financial Management, OUP
2. Van Horne and Wachowicz : Fundamentals of Financial Management, Prentice Hall/ Pearson Education.
3. Brealey and Meyers: Principles of Corporate Finance: Tata McGraw Hill, New Delhi, 2008.
4. Keown, Martin, Petty and Scott (Jr): Financial Management: Principles and Applications; Prentice Hall of India, New Delhi, 2002.
5. Gitman, L.J: Principles of Managerial Finance; Addison Wasley, 2009.
6. Vanhorne, James C: Financial Management and Policy; Prentice Hall of India, New Delhi, 2002.
7. Kishore Ravi, M: Financial Management; Taxman, 2006.

UHU048: Human Resource Management

L	T	P	Cr
2	0	2	3.0

Course Objectives:
This introductory course on Human Resource Management will familiarize the students with the basic concepts, roles, functional areas and activities of HR and help students understand organization‟s employees, their interest, motivation and satisfaction, and their belief of fair treatment- all of which actually impact the firm‟s current performance and sustainability in the long run.

UNIT – I

Human Resource Management: Concept and Challenges, HR Philosophy, Policies, Procedures and Practices.

UNIT – II

Human Resource System Design: HR Profession, and HR Department, Line Management Responsibility in HRM, Measuring HR, Human resources accounting and audit; Human resource information system

UNIT – III

Functional Areas of HRM: recruitment and staffing, benefits, compensation, employee relations, HR compliance, organizational design, training and development, human resource information systems (H.R.I.S.) and payroll.

UNIT – IV

Human Resource Planning: Demand Forecasting, Action Plans– Retention, Training, Redeployment & Staffing, Succession Planning

UNIT – V

Strategic Management of Human Resources: SHRM, relationship between HR strategy and overall corporate strategy, HR as a Factor of Competitive Advantage, Managing Diversity in the Workplace

UNIT – VI

Human Resource Management in Service Sector- Special considerations for Service Sector including

- Managing the Customer – Employee Interaction
- Employee Empowerment and Customer Satisfaction
- Service Failure and Customer Recovery – the Role of Communication and Training
- Similarities and Differences in Nature of Work for the Frontline Workers and the Backend
- Support Services - Impact on HR Practices Stressing Mainly on Performance
- Flexible Working Practices – Implications for HR

Laboratory work:
Further, the topic for class discussion will be mentioned beforehand. Students are required to meet in groups before coming to class and prepare for the topic to be discussed. Instructor may ask the student groups to present their analysis and findings to the class. Instructor can add or change any topic as per requirement.

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

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

1. To understand the issues and challenges involved in managing a diverse workforce.
2. To understand the interplay between, Human Resource System Design and Human Resource Planning in governing human resource information systems.
3. Interpret and apply basic principles of Human Resource Management.
4. To demonstrate the similarities and differences in Manufacturing and Service Sector.
5. To Develop Proficiency in the field of Human resource Management and ability to take rational decisions while performing various Strategic Management activities.

Text Books:

1. Gary Dessler, Human Resource Management.

Reference Books:

1. Ryan D. Zimmerman, Human Resource Management.
2. Deccenzo D A, Human Resource Management.

UHU049: SERVICE SCIENCE & SERVICE OPERATIONAL MANAGEMENT

L	T	P	Cr
3	0	2	4.0

Course Objectives: To provide an understanding the concept of Services and distinguish it from manufacturing goods, make them able to identify characteristics and nature of Services, help the students to comprehend ways to design Services and evaluate them using Service qualities, to make them understand how various methods can be used to operate and manage Service businesses and also how innovation can be approached from Services point of view.

UNIT – I

Introduction: Introduction to the course, Introduction to service operations, Role of service in economy and society, Introduction to Indian service sector

Nature of Services and Service Encounters: Differences between services and operations, Service package, characteristics, various frameworks to design service operation system, Kind of service encounter, importance of encounters

Service-Dominant Logic: From Goods-Dominant logic to Service-Dominant logic, Value Co-creation

UNIT – II

Service Strategy and Competitiveness: Development of Strategic Service Vision (SSV), Data Envelopment Analysis

New Service Development: NSD cycle, Service Blueprinting, Elements of service delivery system

Service Design: Customer Journey and Service Design, Design Thinking methods to aid Service Design

Locating facilities and designing their layout: models of facility locations (Huff's retail model), Role of service-scape in layout design

Service Quality: SERVQUAL, Walk through Audit, Dimensions of Service quality & other quality tools

UNIT – III

Service Guarantee & Service Recovery: How to provide Service guarantee? How to recover from Service failure?

UNIT – IV

Forecasting Demand for Services: A review of different types of forecasting methods for demand forecasting.

Managing Capacity and Demand: Strategies for matching capacity and demand, Psychology of waiting, Application of various tools used in managing waiting line in services.

Managing Facilitating Goods: Review of inventory models, Role of inventory in services

Managing service supply relationship: Understanding the supply chain/hub of service, Strategies for managing suppliers of service

Vehicle Routing Problem: Managing after sales service, Understanding services that involve transportation of people and vehicle, Techniques for optimizing vehicle routes

UNIT – V

Service Innovation: Services Productivity, Need for Services Innovation

Student Project:

Option 1: Choose any service organization around and present it from the perspective of: nature of service, classification of service, blueprint or service design analysis, service quality, and any additional perspective you would like to add.

Option 2: Choose any latest research paper in services and explain your understanding and feedback on the same.

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

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

1. Understand concepts about Services and distinguish it from Goods.
2. Able to identify characteristics and nature of Services.
3. Comprehend ways to design Services and evaluate them using Service qualities.
4. Understand how various methods can be used to operate and manage Service businesses.
5. Understand how innovation can be approached from Services point of view.

Text Books:

1. Fitzsimmons & Fitzsimmons, Service Management: Operations, Strategy, Information Technology, McGraw Hill publications (7^{th} edition).

Reference Books:

1. Wilson, A., Zeithaml, V. A., Bitner, M. J., & Gremler, D. D. (2012). Services marketing: Integrating customer focus across the firm. McGraw Hill.
2. Lovelock, C. (2011). *Services Marketing, 7/e*. Pearson Education India.
3. Reason, Ben, and Lovlie, Lavrans, (2016) Service Design for Business: A Practical Guide to Optimizing the Customer Experience, Pan Macmillan India.
4. Chesbrough, H. (2010). Open services innovation: Rethinking your business to grow and compete in a new era. John Wiley & Sons.

UCT703: IT PROJECT MANAGEMENT

L	T	P	Cr
3	0	2	4.0

Course objectives: After completion of this course, students will learn the techniques to effectively plan, manage, execute, and control projects within time and cost targets with a focus on Information Technology and Service Sector. Students will also learn agile project management techniques such as Scrum and DevOps.

Project Overview and Feasibility Studies- Identification, Market and Demand Analysis, Project Cost Estimate, Financial Appraisal.

Project Scheduling: Project Scheduling, Introduction to PERT and CPM, Critical Path Calculation, Precedence Relationship, Difference between PERT and CPM, Float Calculation and its importance, Cost reduction by Crashing of activity.

Cost Control and Scheduling: Project Cost Control (PERT/Cost), Resource Scheduling & Resource Leveling.

Project Management Features: Risk Analysis, Project Control, Project Audit and Project Termination.

Agile Project Management: Introduction, Agile Principles, Agile methodologies, Relationship between Agile Scrum, Lean, DevOps and IT Service Management (ITIL).

Scrum: Various terminologies used in Scrum (Sprint, product backlog, sprint backlog, sprint review, retro perspective), various roles (Roles in Scrum), Best practices of Scrum.

DevOps: Overview and its Components, Containerization Using Docker, Managing Source Code and Automating Builds, Automated Testing and Test Driven Development, Continuous Integration, Configuration Management, Continuous Deployment, Automated Monitoring.

Other Agile Methodologies: Introduction to XP, FDD, DSDM, Crystal.

Laboratory work: Getting acquainted with the popular PM tools. Using Function Point calculation tools for estimation, comparing with COCOMO estimates, Implementation of various exercises using PERT, CPM methods, Preparing schedule, resource allocation etc. Using MS Project, Preparing an RMMM Plan for a case study, Preparing Project Plan for a Software Project for Lab Project or case study. Exploring about PMBOK (Project Management Body of Knowledge) and SWEBOK (Software Engineering Body of Knowledge) from related website, Implementation of software project management concepts using related tools and technologies.

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

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

1. Describe and apply basic concepts related to IT project planning, scope and feasibility.

2. Analyze IT project estimation techniques.
3. Acquire skills to analyze and manage risks, quality assurance, and project control activities.
4. Describe various project management activities such as tracking, project procurement, configuration management, monitoring.

Text Books:

1. Hughes B. and Cotterell M. and Mall R., Software Project Management, Tata McGraw Hill.
2. Mike Cohn, Succeeding with Agile: Software Development Using Scrum.
3. Pressman R., A practitioner‟s Guide to Software Engineering, Tata McGraw Hill.

Reference Books:

1. Roman Pichler, Agile Product Management with Scrum.
2. Ken Schwaber, Agile Project Management with Scrum (Microsoft Professional).

UCT721: COGNITIVE SCIENCE & ANALYTICS

L	T	P	Cr
2	1	2	3. 5

Course Objectives:
To elaborate on the fundamentals of analytics and cognitive science and provide a foundation for understanding the challenges and applications using varied data. This course will provide exposure to different applications by applying multiple analytics techniques.

UNIT 1: FOUNDATIONAL AREAS OF ANALYTICS

Introduction to Analytics: Definition, Description & Evolution of Analytics, History of Analytics, and Applicability of Analytics with development of Technology and Computer, How Analytics entered mainstream

Concepts of Analytics: Various overlapping concepts and fields of Analytics such as Data Mining, Machine Learning, Artificial Intelligence and Simulation

Emerging Areas in Analytics: Understanding of emerging research areas of Analytics: Mathematical programming, Evolutionary computation, Simulation, Machine learning/data mining, Logic-based models, and, Combinations of categories

Value Chain of Analytics: Descriptive Analytics Covering Exploratory Data Analysis & Basic of Statistics, Diagnostics Analytics: BI/Analysis, Trend, Pattern, Simultaneous Relationship, Predictive Analytics: Cause-Effect Relationship and Futuristic prediction in terms of probabilities, Continuous & Categorical Predictions, Simulation, Optimization, Multi-faceted Intelligent Technology driven Analytics combining Machine Intelligence with Human Brain Processing Abilities

UNIT 2: FOUNDATIONAL AREAS OF COGNITIVE SCIENCE

Introduction & Evolution of Cognitive Science: Introduction to the study of cognitive sciences, Brief history of cognitive science development and Methodological concerns in philosophy
Understand Brain and Sensory Motor Information: Fundamentals of Neuro Science, Processing of sensory information in the brain, and Brain Imaging Elements
Language & Linguistic Knowledge: Background and details of Syntax & Semantics, Understanding of Generative Linguistic
Memory & Processing: Theory of Information Processing, Fundamentals of Short term Memory

UNIT 3: DATA THEORY & TAXONOMY OF DATA

Data as a whole: Understanding of Data as a whole for distinguishing and relating various types of data and Categorization of Data: Structured, Unstructured Data, Quantitative & Qualitative Data.

Views of Data: Understanding Data as an interdisciplinary framework for learning methodologies:covering statistics, neural networks, and fuzzy logic

Measurement & Scaling Concepts: Measurement of variables and commonly used statistical tools: Number of procedures for measurement of the variables,

Categorization procedures, Scale construction procedures and Techniques of data processing forqualitative as well as quantitative data;

Various types of Scales: Nominal, Ordinal, Interval & Ratio Scales

UNIT 4: MULTIVARIATE DATA ANALYTICS & COGNITIVEANALYTICS

Overview: High level overview of Categorization of Techniques: Inter-dependence Relationship Techniques and Dependence Relationship Techniques

Overview of Commonly Used Inter-dependence Techniques: Factor Analysis, Principal Component Analysis (PCA), Cluster Analysis

Overview of Commonly Used Dependence Techniques: Regression, Logistic Regression

Analytics Value Chain &Application of Analytics across Value Chain:

a. Basic statistical concepts such as Descriptive & Diagnostics statistics, concept of random variables, discrete and continuous random variables, confidence interval, hypothesis testing, analysis of variance and correlation.

b. Predictive analytics techniques such as multiple linear regression, logistic regression, decision tree learning Clustering and forecasting techniques.

Prescriptive analytics Concepts: linear programming, integer programming, goal programming & stochastic models

c. Cognitive analytics Concepts: Text Analytics, Learning Analytics, Data Mining, Cognitive Systems, Cognitive Computing, Learning Data Science, Machine Learning, Big data Analytics and Business analytics

UNIT 5: ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

Fundamentals of Artificial Intelligence: Various areas of AI:

a. Knowledge: Text Analytics, Topic Modelling, Natural Language Processing (NLP), Natural Language Generation (NLG), Natural Language Understanding (NLU), Named-entity recognition(NER)
b. Perception: Image Analytics, Video Analytics & Audio Analytics
c. Memory: Cognitive Engagement: BOTs, Virtual & Digital Assistants, Augmented Reality, Virtual Reality, Mixed Reality
d. Learning: Intelligent Automation

Spectrum of AI

Reactive Machine: Low memory, works on Known rules, such as

a. ObjectDetection/Games/Recommendations specific to known Rules
b. Limited Memory: Memory used to learn and improve continuously such as Most ML Models, Automated Vehicles
c. Theory of Mind: Machine Understands and responds such as BoTs/Virtual/Digital Assistants
d. Self-Aware: Human like intelligence such as Super Robots in Space etc.

UNIT 6: APPROACH & METHODOLOGY

World Standard Methodology: CRISP-DM Methodology, SEMMA Methodology

Real Life Work around Multi-Variate Analytics: A few Selected Commonly used Techniques: Predictive & Classification Models, Regression, Clustering

Real Life Work around Artificial Intelligence, Machine Learning and Deep Learning: A few SelectedCommonly used Techniques & Algorithms: ANN (Artificial Neural Network), CNN (Convolutional Neural Network), RNN (Recurrent Neural Network);

RN Architecture: LSTM, Bidirectional LSTM, Gated Recurrent Unit (GRU), CTRNN (Continuous Time RNN) CNN Architectures: VGG16, Alexnet, InceptionNet, RestNet, Googlenet
Object Detection models: R-CNN, Fast R-CNN, Faster R-CNN, cascade R-CNN. Mask RCNN, Single ShotMultiBox Detector (SSD) ,You Only Look Once (YOLO), Single-Shot Refinement Neural Network for Object Detection (RefineDet), Retina-Net, Autoencoders: Denoising Autoencoder, GAN
Transformers: Attention based Encoder and Decoder: Eg- BERT(Bidirectional Encoder Representations from Transformers), Generative Pretrained Transformers GPT-3, GPT-2, BERT, XLNet, and RoBERTa

Laboratory Work:

Structured Data Analytics: Segmentation & Clustering, Classification & Prediction, Forecasting Association Mining & Sequence Mining
Textual Data Analytics: Natural Language Processing (NLP), Natural Language Generation (NLG), Natural Language Understanding (NLU), Named-entity recognition (NER) driven Analytics: Key Word Extraction, Text Summarization, Insight Generation
Image Analytics: Malaria/Carcinoma/COVID detection, Visual inspection for QA/QC
Video Analytics: Motion based Behavior Recognition, Behavioural Observations, and Parkinson's Disease Prediction
Audio Analytics: Speech to Text, Text to Speech, Transcript Services
Artificial Intelligence, Machine Learning driven Automation: Banking Process Automation, Hospital Triage Process Automation AR/VR enabled Guided Operations
Conversational Analytics: Artificial Intelligence, Machine Learning, Augmented Reality, Virtual Reality, Robotics, Digital/Virtual Assistant, Chat-BOT/ Program BOT, Email-BOT

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

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

1. Understand and apply the fundamental concepts of analytics and cognitive science.
2. Handle, clean, and analyze varied types of data.
3. Apply advanced techniques of artificial intelligence and machine learning to real-world problems.
4. Develop a solution using advanced data analytics techniques for different kinds of data such as text, image, etc.

Text Books:

Unit 1

1. Hall, P., Phan, W., & Whitson, K. (2016). Evolution of Analytics. O'Reilly MediaIncorporated.

Unit 2

1. Cognitive Science: An Introduction to the Science of the Mind by José Luis Bermúdez
2. Cognitive Computing and Big Data Analytics by Judith S. Hurwitz (Author), Marcia Kaufman(Author), Adrian Bowles (Author)
3. Cognitive Science and Artificial Intelligence Advances and Applications: Authors: Gurumoorthy, Sasikumar, Rao, B Narendrakumar, Gao, Xiao-Zhi

Unit 3

1. Cherkassky, V., & Mulier, F. M. (2007). Learning from data: concepts, theory, and methods. John Wiley & Sons.
2. The visual display of Quantitative Information: Edward Tufte, Graphics Press, 2001.
3. Scaling Measurement and Statistical Tools for Extension Workers by Krunal D. Gulkari,Hemant V. Borate , Mayur S. Shitap , 2016.

Unit 4

1. Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). Multivariate data analysis. Englewood Cliff. New Jersey, USA, 5(3), 207-2019.

2. Kumar, U. D. (2017). Business analytics: The science of data-driven decision making. Wiley.

3. Özköse, H., Arı, E. S., & Gencer, C. (2015). Yesterday, today and tomorrow of big data.Procedia-Social and Behavioral Sciences, 195, 1042-1050.

4. Gudivada, Venkat N., M. T. Irfan, E. Fathi, and D. L. Rao. "Cognitive analytics: Going beyond big data analytics and machine learning." In Handbook of statistics, vol. 35, pp. 169-205. Elsevier,2016.

Unit 5

1. Kao, A., & Poteet, S. R. (Eds.). (2007). Natural language processing and text mining. Springer Science & Business Media.

2. Demystifying Artificial intelligence: Simplified AI and Machine Learning concepts for Everyone (English Edition) Paperback – Import, 5 January 2021by Prashant Kikani

3. Kelleher, J. D., Mac Namee, B., & D'arcy, A. (2020). Fundamentals of machine learning for predictive data analytics: algorithms, worked examples, and case studies. MIT press.

4. Goodfellow, Ian, Yoshua Bengio, Aaron Courville, and Yoshua Bengio. Deep learning. Vol. 1, no. 2. Cambridge: MIT press, 2016.

5. Practical Deep Learning for Cloud, Mobile, and Edge: Real-World AI & Computer-Vision Projects Using Python, Keras & TensorFlow 1st Edition,

6. Conversational Chatbots for Analytics Third Edition by Gerardus Blokdyk

7. BORNET, P. B. (2020). Intelligent automation: Welcome to the world of hyperautomation. World Scientific Publishing Company.

Unit 6:

1. Maimon, O., & Rokach, L. (Eds.). (2005). Data mining and knowledge discovery handbook.

2. Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). Multivariate data analysis. Englewood Cliff. New Jersey, USA, 5(3), 207-2019.

3. Zhang, C., & Ma, Y. (Eds.). (2012). Ensemble machine learning: methods and applications. Springer Science & Business Media.

Reference Books:

Unit 1

1. Seminal Paper: The evolution of analytics and implications for industry and academic programs MR Bowers, JD Camm, G Chakraborty - Interfaces, 2018 - pubsonline.informs.org.

Unit 2

1. Cognitive Analytics: Concepts, Methodologies, Tools, and Applications (4 Volumes) Information Resources Management Association (USA)A first course in Probability, S. M. Ross, Prentice Hall.

Unit 3

1. Seminal paper: Shneiderman, B. (2003). The eyes have it: A task by data type taxonomy for information visualizations. In The craft of information visualization (pp. 364-371). Morgan Kaufmann.C: The Complete Reference, (Fourth Edition), Herbert Schildt, McGraw Hill.

UCT722: INTRODUCTION TO IOT

L	T	P	Cr
2	1	2	3.5

Course objectives: This course will help students understand basic principles and concepts of Internet-of-Things use cases, applications, architecture and technologies. Students will get an overview of an end to end IoT system encompassing the edge, cloud and application tiers. This course will build upon the foundations created in the pre-requisite courses and will equip the students to architect a complete IoT application on their own. The lab exercises will consist of hands-on experiments that will lead to building an IoT application end-to-end. Some of the specialized topics will be covered via student seminars where students are expected to research and present their findings in a seminar format.

UNIT – I

Introduction to IoT and Use cases: Understanding basic concepts of IoT, Consumer IoT vs Industrial Internet, Fundamental building blocks, Use Cases of IoT in various industry domains.

UNIT – II

Architecture: IoT reference architectures, Industrial Internet Reference Architecture, Edge Computing, IoT Gateways, Data Ingestion and Data Processing Pipelines, Data Stream Processing.

UNIT – III

Sensors and Industrial Systems: Introduction to sensors and transducers, integrating sensors to sensor processing boards, introduction to industrial data acquisition systems, industrial control systems and their functions.

UNIT – IV

Networking and Communication for IoT: Recap of OSI 7 layer architecture and mapping to IoT architecture, Introduction to proximity networking technologies (ZigBee, Bluetooth, Serial Communication), Industrial network protocols (Modbus, CANbus), Communicating with cloud applications (web services, REST, TCP/IP and UDP/IP sockets, MQTT, Web Sockets, protocols. Message encoding (JSON, Protocol Buffers).

UNIT – V

IoT Data Processing and Storage: Time Series Data and their characteristics, time series databases, basic time series analytics, data summarization and sketching, dealing with noisy and missing data, anomaly and outlier detection,

IoT Seminars:

Selected topics in IoT should be handled via student seminars. Recommended that students form a group do research on at least one of the following topics and present it through

seminars. They are expected to do a literature survey of the topic and present their survey paper to the class. The suggested topics are –

a) **IoT Applications**
   - Smart Cities
   - Connected Vehicles and Telematics
   - Smart Grids
   - Smart Homes
b) **IoT data visualization**
c) **Survey of cloud based IoT platforms**
d) **Low power wide area networks for IoT**
e) **IoT device management**
f) **Survey of chips, embedded modules and development boards for IoT devices**
g) **Embedded and real-time operating systems for IoT**
h) **IoT Security**
   - Security risks in IoT
   - Securing IoT endpoint devices and secure communication protocols for IoT
   - Security and Privacy of IoT data

Lab Exercises

1. Setting up the Arduino Development Environment, connecting analog sensors to an Arduino Boarding and reading analog sensor data.
2. Digital Input and Output reading using and Arduino board and Arduino Development Environment.
3. Integrate an Arduino Board to a Raspberry Pi computer and send sensor data from Arduino to the R Pi.
4. Setup Python on the R Pi and run sample R Pi programs on the R Pi. Read the data from Arduino using Python language.
5. Connect a R Pi Camera module to the Raspberry Pi and using Python programming capture still images and video.
6. Set up TCP/IP socket server on a PC. Send a message from the R Pi to the PC using socket communication.
7. Set up a MQTT broker on the PC. Send data from R Pi to PC using MQTT protocol. Receive data from PC to R Pi using MQTT protocol.
8. Connect LED lights to an Arduino. Connect the Arduino to the R Pi. Send Message from PC to R Pi via MQTT protocol. On receipt of the message, toggle the LED lights on the Arduino.
9. Set up an account in a cloud service (such as Google / AWS or Azure). Set up a simple Http server using a language of your choice. Push the image captured from the R Pi camera to this web service. On receiving the image, store the image in a database or file.
10. Develop a mobile application to view the images captured by the R Pi camera.

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

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

1. To Test and design some IOT based prototypes.

2. Understand the working principles of different types of sensors.
3. To describe various layers of IoT protocols stack along with its functionalities.
4. To understand the privacy and security issues and their related industry based standard solutions.
5. To provide skill and knowledge for demonstrating and building IoT based projects with the help of coding, hardware devices, sensor requirements, emulating and testing.
6. To develop an understanding for mapping wireless communication protocols and networking concepts for Industrial IoT deployments.

Text Books:

1. The Internet of Things, Samuel Greengard, MIT Press Essential Knowledge Series.

Reference Books / Links:

1. Industrial Internet Reference Architecture - http://www.iiconsortium.org/IIRA.htm.
2. World Economic Forum Report on Industrial Internet of Things - https://www.weforum.org/reports/industrial-internet-things.
3. 50 Sensor Applications for a Smarter World - http://www.libelium.com/resources/top_50_iot_sensor_applications_ranking/.
4. Visualizing Data-Exploring and Explaining Data with the Processing Environment, By Ben Fry, Publisher: O'Reilly Media.
5. Raspberry Pi Computer Architecture Essentials, by Andrew K Dennis.
6. Getting Started with Arduino, M. Banzi, O Reilly Media.
7. GSMA IoT Security Guidelines & Assessment - https://www.gsma.com/iot/future-iot-networks/iot-security-guidelines/.

UCT723: Cryptology

L	T	P	Cr
2	1	2	3.5

Course Objectives: To provide an understanding of security services and cryptography, prevent the security attacks on information systems using secure algorithms and need of quantum cryptographic solutions.

Introduction to Cryptography: Elementary number theory, Pseudo-random bit generation, Elementary cryptosystems.

Basic security services: confidentiality, integrity, availability, non-repudiation, privacy

Symmetric key cryptosystems: Stream Cipher: Basic Ideas, Hardware and Software Implementations, Examples with some prominent ciphers: A5/1, Grain family, RC4, Salsa and ChaCha, HC128, SNOW family, ZUC; Block Ciphers: DES, AES, Modes of Operation; Hash Functions; Authentication

Public Key Cryptosystems: RSA, ECC; Digital signatures

Security Applications (Selected Topics): Electronic commerce (anonymous cash, micro-payments), Key management, Zero-knowledge protocols, Cryptology in Contact Tracing Applications, Issues related to Quantum Cryptanalysis.

Introductory topics in Post-Quantum Cryptography: Refer to https://csrc.nist.gov/projects/post-quantum-cryptography. May discuss any two ciphers from this list.

Laboratory Work:
Introduction to Wireshark and N map commands for scanning, implement various symmetric key cryptosystems, OpenSSL for Public Key cryptosystems and Digital certificate generation, Quantum Cryptography.

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

1. Understand the need of security services for strong cryptosystems.
2. Apply and interpret various cryptograhic algorithms for information security.
3. Understand public key cryptosystems and key management to establish mutual trust.
4. Comprehend the key concepts of quantum cryptography.

Text Books:

1. *Cryptography, Theory and Practice.* D. R. Stinson, CRC Press.
2. *Handbook of Applied Cryptography.* A. J. Menezes, P. C. van Oorschot, and S. A. Vanstone, CRC Press.
3. Cryptography and Network Security. W. Stallings, Prentice Hall.

Reference Books:

1. A course in number theory and cryptography. N. Koblitz:, GTM, Springer.
2. Security Engineering, R. Anderson, Wiley
3. RC4 Stream Cipher and Its Variants. G. Paul and S. Maitra: CRC Press, Taylor & Francis Group, A Chapman & Hall Book, 2012.
4. Design & Cryptanalysis of ZUC - A Stream Cipher in Mobile Telephony. C. S. Mukherjee, D. Roy, S. Maitra, Springer 2020.
5. Contact Tracing in Post-Covid World - A Cryptologic Approach. P. Chakraborty, S. Maitra, M. Nandi, S. Talnikar, Springer 2020.
6. Presskil Lecture notes: Available online: http://www.theory.caltech.edu/~preskill/ph229/.

UCT732: Advanced Social, Text and Media Analytics

L	T	P	Cr
2	0	2	3.0

Course Objectives: To provide an understanding of various text mining operations, preprocessing techniques, content analysis, sentiment analysis, web analytics tools and social media analytics.

Text Mining: Introduction, Core text mining operations, Pre-processing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction, Text mining applications

Methods & Approaches: Content Analysis; Natural Language Processing; Clustering & Topic Detection; Simple Predictive Modelling; Sentiment Analysis; Sentiment Prediction

Web Analytics: Web analytics tools, Clickstream analysis, A/B testing, online surveys; Web search and retrieval, Search engine optimization, Web crawling and Indexing, Ranking algorithms, Web traffic models

Social Media Analytics: Social network and web data and methods. Graphs and Matrices. Basic measures for individuals and networks. Information visualization; Making connections: Link analysis. Random graphs and network evolution. Social contexts: Affiliation and identity; Social network analysis

Laboratory Work:
Usage of R or Python to carry out text mining operations, sentiment analysis along with sentiment prediction. Insight to Web Analytics by the use of Google Analytics and Adobe Analytics along with Social Media Analytics tools.

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

1. Understand the concept of Text Mining along its operations and its usages in different applications
2. Apply and interpret methods for performing Content Analysis, Clustering, Predictive modeling and Sentiment Analysis.
3. Illustrate the usage of various Web Analytics Tool for carrying out analysis, testing and optimization of Websites.
4. Comprehend the basis of Web Traffic Models, Ranking Algorithms, Information Visualization and Social Media Analytics on various social media sites.

Text Books:

1. Ronen Feldman and James Sanger, "The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data", Cambridge University Press, 2006.

2. Hansen, Derek, Ben Sheiderman, Marc Smith. 2011 Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 304.
3. Avinash Kaushik. 2009. Web Analytics 2.0: The Art of Online Accountability.
4. Hanneman, Robert and Mark Riddle. 2005. Introduction to Social Network Method.

Reference Books:

1. Wasserman, S. & Faust, K. (1994). Social network analysis: Methods and applications. New York: Cambridge University Press.
2. Monge, P. R. & Contractor, N. S. (2003). Theories of communication networks. New York: Oxford University Press. http://nosh.northwestern.edu/vita.html.

UCT733: MOBILE COMPUTING

L	T	P	Cr
2	0	2	3.0

Course Objectives:

1. To provide guidelines, design principles and experience in developing applications for small, mobile devices, including an appreciation of context and location aware services.
2. To develop an appreciation of interaction modalities with small, mobile devices (including interface design for non-standard display surfaces) through the implementation of simple applications and use cases.
3. To introduce wireless communication and networking principles, that support connectivity to cellular networks, wireless internet and sensor devices.
4. To understand the use of transaction and e-commerce principles over such devices to support mobile business concepts.
5. To appreciate the social and ethical issues of mobile computing, including privacy.

Introduction: Overview of wireless and mobile infrastructure; Preliminary concepts on cellular architecture; Design objectives and performance issues; Radio resource management and interface; Propagation and path loss models; Channel interference and frequency reuse; Cell splitting; Channel assignment strategies; Overview of generations:- 1G to 5G.

Location and handoff management: Introduction to location management (HLR and VLR); Mobility models characterizing individual node movement (Random walk, Fluid flow, Markovian, Activity based); Mobility models characterizing the movement of groups of nodes (Reference point based group mobility model, Community based group mobility model); Static (Always vs. Never update, Reporting Cells, Location Areas) and Dynamic location management schemes (Time, Movement, Distance, Profile Based); Terminal Paging (Simultaneous paging, Sequential paging); Location management and Mobile IP; Overview of handoff process; Factors affecting handoffs and performance evaluation metrics; Handoff strategies; Different types of handoffs (soft, hard, horizontal, vertical).

Wireless transmission fundamentals: Introduction to narrow and wideband systems; Spread spectrum; Frequency hopping; Introduction to MIMO; MIMO Channel Capacity and diversity gain; Introduction to OFDM; MIMO-OFDM system; Multiple access control (FDMA, TDMA,CDMA, SDMA); Wireless local area network; Wireless personal area network (Bluetooth and zigbee).

Mobile Ad-hoc networks: Characteristics and applications; Coverage and connectivity problems; Routing in MANETs.

Wireless sensor networks: Concepts, basic architecture, design objectives and applications; Sensing and communication range; Coverage and connectivity; Sensor placement; Data relaying and aggregation; Energy consumption; Clustering of sensors; Energy efficient Routing (LEACH).

Cognitive radio networks: Fixed and dynamic spectrum access; Direct and indirect spectrum sensing; Spectrum sharing; Interoperability and co-existence issues; Applications of cognitive radio networks.

D2D communications in 5G cellular networks: Introduction to D2D communications; High level requirements for 5G architecture; Introduction to the radio resource management, power control and mode selection problems; Millimeter wave communication in 5G.

Laboratory Work:

Development and implementation of different network protocols using network simulators such as NS-3 and OMNET++.

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

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

1. A working understanding of the characteristics and limitations of mobile hardware devices including their user-interface modalities.
2. The ability to develop applications that are mobile-device specific and demonstrate current practice in mobile computing contexts.
3. A comprehension and appreciation of the design and development of context-aware solutions for mobile devices.
4. An awareness of professional and ethical issues, in particular those relating to security and privacy of user data and user behaviour.

Text Books:

1. Mobile Communications. Jochen Schiller, Pearson Education.
2. Wireless Communications. Andrea Goldsmith, Cambridge University Press.

Reference Books:

1. Wireless Communications: Principles and Practice. Theodore Rappaport, Pearson Education.
2. Wireless Communications. Ezio Biglieri, MIMO, Cambridge University Press.
3. Handbook of Wireless Networking and Mobile Computing. Ivan Stojmenovic, Wiley.
4. Dynamic Location Management in Heterogeneous Cellular Networks. James Cowling,
5. MIT Thesis. http://people.csail.mit.edu/cowling/hons/jcowling-dynamic-Nov04.pdf
6. Location Management in Wireless Cellular Networks. Travis Keshav, https://www.cse.wustl.edu/~jain/cse574-06/ftp/cellular_location.pdf
7. Location Management in Wireless Data Networks. Fahd A. Batayneh, https://www.cse. wustl.edu/~jain/cse574-06/ftp/wireless_location.pdf
8. Principles of Mobile Communication. Gordon L. Stber, Springer.
9. Wireless Device-to- Device Communications and Networks. Lingyang Song, Dusit Niyato, Zhu Han, and Ekram Hossain, Cambridge University Press.
10. Principles of Cognitive Radio. Ezio Biglieri, Andrea J. Goldsmith, Larry J. Greenstein, Narayan Mandayam and H. Vincent Poor, Cambridge UniversityPress.
11. Wireless Sensor Networks: Architectures and Protocols. Edgar H. Callaway, Jr. and Edgar H. Callaway, CRC Press.

UCT891: PROJECT SEMESTER

L	T	P	Cr
-	-	-	15

Course Objectives: The project semester is aimed at developing the undergraduate education programme in engineering to include a practical training in a professional engineering setting (a company, top educational institution, research institute, *etc*.) hereafter referred to as "host organization" as deemed appropriate. The participating organizations are ones that are either already visiting Thapar Institute of Engineering & Technology for placement or are forming new relationships for mutual benefit. The project semester gives the student an opportunity to translate engineering theory into practice in a professional engineering environment. The technical activity should be related to both the student‟s engineering studies and to the host organization‟s. 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. It consolidates the student‟s prior learning and provides a context for later research studies. The purpose of the project semester is to further develop the understanding related to the implementation, design and theoretical aspects of the computer science and its application to the practical problems. Many of the subjects that a student had studied in the university have a direct impact on what the student will be doing in the software industry. Student will extend and deepen the knowledge of computer science & engineering while working within the span of project semester.

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

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

1. Develop skills necessary for structuring, managing, and executing the projects.
2. Design, develop, debug, document, and deliver a project and learn to work in a team environment.
3. Develop written and oral communication skills.
4. Become proficient with software development tools and environments.
5. Apply interdisciplinary knowledge to engineering design solutions, taking into account professional and ethical issues.

UCT802: 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.

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

Text Books / Reference 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.

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

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

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

UCT801: 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.

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: 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 Objectives (COs):

After the completion of the course, the student 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.
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.

UCT898:CAPSTONE PROJECT

L	T	P	Cr
-	-	-	08

Course Objectives: To facilitate the students learn and apply their earned skill set for the system development life cycle in Computer Science and Business Systems. As a part of a team, the students will make a project, which emphasizes hands-on experience, and integrates analytical, design, and development 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: This course is of six months and is taken by the student not opting project semester at some software company or research institute. 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, in which the basic sciences, mathematics, and the engineering are applied to convert resources optimally to meet the stated needs. It typically includes both analysis and synthesis performed in an iterative cycle. As part of their design experience, students have an opportunity to define and determine the problem and its scope. The project demonstrates that students have adequate exposure to design, as defined, in engineering contexts. 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 1-4 students, and one of them is working as team leader. Team lead is having an additional responsibility for maintaining the daily diary. Each Group will work under mentorship of a faculty supervisor as assigned by the department.

Each group must meet the assigned supervisor 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 fulfillment of the attendance as well as the successful completion of the project. The faculty supervisor of the project will continuously judge the development of the workings of the assigned groups.

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

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

1. Develop skills necessary for time management, reporting and carrying out projects within an organization/industry.
2. Design, develop, debug, document, and deliver automated solutions for real world problems and learn to work in a team environment.
3. Develop technical report writing and verbal communication skills.
4. Experience contemporary computing systems, tools and methodologies and apply experimental and data analysis techniques to the software projects.
5. Apply interdisciplinary fundamentals to the software projects taking into account professional and ethical issues.