B.E. /B.Tech in Computer Science & Business Systems

Semester 1

TCS

Computer Science & Business Systems

Semester 1 Curriculum

B.E. /B.Tech in Computer Science & Business Systems

Semester 1

Discrete Mathematics (PCC-CS401)

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.

Text Books:

1. *Topics in Algebra,* I. N. Herstein, John Wiley and Sons.
2. *Digital Logic & Computer Design,* M. Morris Mano, Pearson.
3. *Elements of Discrete Mathematics,* (Second Edition) C. L. LiuMcGraw Hill, New Delhi.
4. *Graph Theory with Applications,* J. A. Bondy and U. S. R. Murty, Macmillan Press, London.
5. *Mathematical Logic for Computer Science,* L. Zhongwan, World Scientific, Singapore.

Reference Books:

1. *Introduction to linear algebra.* Gilbert Strang.
2. *Introductory Combinatorics,* R. A. Brualdi, North-Holland, New York.
3. *Graph Theory with Applications to Engineering and Computer Science,* N. Deo, Prentice Hall, Englewood Cliffs.
4. *Introduction to Mathematical Logic,* (Second Edition), E. Mendelsohn, Van-Nostrand, London.

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STATISTICS, PROBABILITY AND CALCULUS

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.

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. Graybill and 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.

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Semester 1

FUNDAMENTALS OF COMPUTER SCIENCE + Lab

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, Initialisation, 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, Initialisation 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.

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FUNDAMENTALS OF COMPUTER SCIENCE + Lab (continued)

Laboratory

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

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.

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Semester 1

PRINCIPLES OF ELECTRICAL ENGINEERING + Lab

Introduction: Concept of Potential difference, voltage, current, Fundamental linear passive and active elements to their functional current-voltage relation, Terminology and symbols in order to describe electric networks, voltage source and current sources, ideal and practical sources, concept of dependent and independent sources, Kirchhoff-s laws and applications to network solutions using mesh and nodal analysis, Concept of work, power, energy, and conversion of energy.

DC Circuits: 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.

AC Circuits: AC waveform definitions, form factor, peak factor, study of R-L, R-C,RLC series circuit, R-L-C parallel circuit, phasor representation in polar and rectangular form, concept of impedance, admittance, active, reactive, apparent and complex power, power factor, 3 phase Balanced AC Circuits (人-Δ & 人-人).

Electrostatics and Electro-Mechanics: Electrostatic field, electric field strength, concept of permittivity in dielectrics, capacitor composite, dielectric capacitors, capacitors in series and parallel, energy stored in capacitors, charging and discharging of capacitors, Electricity and Magnetism, magnetic field and Faraday's law, self and mutual inductance, Ampere's law, Magnetic circuit, Single phase transformer, principle of operation, EMF equation, voltage ratio, current ratio, KVA rating, efficiency and regulation, Electromechanical energy conversion.

Measurements and Sensors: Introduction to 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). Electrical Wiring and Illumination system: Basic layout of the distribution system, Types of Wiring System &Wiring Accessories, Necessity of earthing, Types of earthing, Safety devices & system.

For Further Reading - Principle of batteries, types, construction and application, Magnetic material and B-H Curve, Basic concept of indicating and integrating instruments.

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PRINCIPLES OF ELECTRICAL ENGINEERING + Lab (continued)

Laboratory

1. Familiarization of electrical Elements, sources, measuring devices and transducers related to electrical circuits

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. Verification of relation in between voltage and current in three phase balanced star and delta connected loads.

8. Demonstration of measurement of electrical quantities in DC and AC systems.

Text Books:

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

Reference Books:

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

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PHYSICS FOR COMPUTING SCIENCE + Lab

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.

Quantum Mechanics: Introduction - Planck's quantum theory- Matter waves, de-Broglie wavelength, Heisenberg's Uncertainty principle, time independent and time dependent Schrödinger's wave equation, Physical significance of wave function, Particle in a one dimensional potential box, Heisenberg Picture.

Crystallography: Basic terms-types of crystal systems, Bravais lattices, miller indices, d spacing, Atomic packing factor for SC, BCC, FCC and HCP structures.

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, CO_2 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.

PHYSICS FOR COMPUTING SCIENCE + Lab (continued)

Laboratory

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.

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.

Reference Books:

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

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Business Communication & Value Science - I

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Lectures: 3 Hr./Week	**Semester Examination: 50 marks**	**4**
Tutorials: 0 Hr. / Week	**Continuous Assessment: Yes**	
Lab: 2-4 Hrs. / Week	**Term Work: 50 marks**	

Course ID:

1.6 (Year 1 Semester 1)

	Leadership Oriented Learning (LOL)	

Nature of Course	Behavioral
Pre requisites	Basic Knowledge of high school English

Course Objectives:

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

Course Outcomes:

Upon completion of the course, students shall have ability to

C1.6.1	Recognize the need for life skills and values	[U]
C1.6.2	Recognize own strengths and opportunities	[U]
C1.6.3	Apply the life skills to different situations	[AP]
C1.6.4	Understand the basic tenets of communication	[U]
C1.6.5	Apply the basic communication practices in different types of communication	[AP]

Course Contents:

- **Overview of the course** with immersion activity
- **Overview of biz communication**
- **Self-awareness, confidence and communication**
- **Essentials of Business communication**

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- **Application of communication skills**
- **Application of Life Skills**
- **Assignment**

	Total Hours:	65

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. Saroj Hiremath

Web References:

1	Train your mind to perform under pressure- Simon sinek https://curiosity.com/videos/simon-sinek-on-training-your-mind-to-perform-under-pressure-capture-your-flag/
2	Brilliant way one CEO rallied his team in the middle of layoffs https://www.inc.com/video/simon-sinek-explains-why-you-should-put-people-before-numbers.html
3	Will Smith's Top Ten rules for success https://www.youtube.com/watch?v=bBsT9omTeh0

Online Resources:

1	https://www.coursera.org/learn/learning-how-to-learn
2	https://www.coursera.org/specializations/effective-business-communication

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C1.6.1	Understand	Immersion (interview)	5
C1.6.2	Understand	Create Resume	4

C1.6.3	Apply	Group Assignment – community service	5
C1.6.4	Understand	Group activities	3
C1.6.5	Apply	Record a conversation	3
Summative Assessment based on End Semester Project			
Bloom's Level			
Understand	Paper		50
Apply	Trek followed by project		
Analyse			

Lesson Plan

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1	Recognize the need for life skills and values	Understand	**Overview of LOL** (include activity on introducing self)	Lecture & reflection	1 hour
			Class activity – presentation on favorite cricket captain in IPL and the skills and values they demonstrate	Activity	1 hour
			Self-work with immersion – interview a maid, watchman, sweeper, cab driver, beggar and narrate what you think are the values that drive them	Immersion activity	2 hours
			Overview of business communication	Lecture with videos	1 hour
			Activity: Write a newspaper report on an IPL match	Class activity with 3 iterations - Formative Evaluation	1 hour
			Activity: Record a conversation between a celebrity and an interviewer	Class activity with 3 iterations - Formative Evaluation	1 hour

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Quiz Time	Summative Evaluation for Unit	30 mins
	Recognize own strengths and opportunities	Understand	**Self-awareness** – identity, body awareness, stress management	Anubhaab Activities (Please conduct at least one activity per week and include the Meditation session in it)	4 hours
2	Understand the basic tenets of communication Unit name: Be At Ease (BAE) (in Millennial lingo it means Before Anyone Else)	Understand	**Essential Grammar – I:** Refresher on Parts of Speech – Listen to an audio clip and note down the different parts of speech followed by discussion Tenses: Applications of tenses in Functional Grammar – Take a quiz and then discuss	Lecture with audio and video	1 hour
			Sentence formation (general & Technical), Common errors, Voices. Show sequence from film where a character uses wrong sentence structure (e.g. Zindagi Na Milegi Dobara where the characters use 'the' before every word)	Lecture with video/audio	1 hour
			Communication Skills: Overview of Communication Skills Barriers of communication, Effective communication		1 hour

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Types of communication- verbal and non – verbal – Role-play based learning **Importance of Questioning**	Activity based learning	1 hour
			Listening Skills: Law of nature- Importance of listening skills, Difference between listening and hearing, Types of listening.	Activity based learning	1 hour
	Recognize own strengths and opportunities	Understand	**Expressing self**, connecting with emotions, visualizing and experiencing purpose	Anubhaab Activities (Please conduct at least one activity per week and include the Meditation session in it)	4 hours
	Apply the basic communication practices in different types of communication	Apply	**Activity:** Skit based on communication skills	Formative Evaluation	4 hours
			Evaluation on Listening skills – listen to recording and answer questions based on them	Formative Evaluation	30 mins
3	Understand the basic tenets of communication Talk Mail Write (TMW) - In Millennial it means **That Moment When**	Understand	**Email writing**: Formal and informal emails, activity	Activity based learning	1 hour
			Verbal communication: Pronunciation, clarity of speech	Audio and video based learning	30 minutes
			Vocabulary Enrichment: Exposure to words from General Service List (GSL) by West, Academic word list (AWL) technical specific terms related to the field of technology, phrases, idioms, significant	Activity based learning (Group Discussion) Flipped classroom	1 hour

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			abbreviations formal business vocabulary – Read Economic Times, Reader's Digest, National Geographic and take part in a GD, using the words you learnt/liked from the articles. Group discussion using words learnt	where students will study words before coming to class	
			Practice: Toastmaster style Table Topics speech with evaluation	Activity based learning	2 hours over 2/3 days
			Written Communication: Summary writing, story writing	Activity based learning	1 hour
			Build your CV – start writing your comprehensive CV including every achievement in your life, no format, no page limit	Formative Evaluation	30 minutes
	Apply the basic communication practices in different types of communication	Apply	**Project:** Create a podcast on a topic that will interest college students	Formative Evaluation	1 hour
	Recognize own strengths and opportunities	Understand	**Life skill:** Stress management, working with rhythm and balance, colours, and teamwork	Anubhaab Activities (Please conduct at least one activity per week and include the Meditation session in it)	4 hours
	Apply the basic communication practices in different types of communication	Apply	**Project:** Create a musical using the learnings from unit	Formative Evaluation	2 hours

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
4	**Unit 4** Recognize the need for life skills and values Unit name: Realities of Facing Life (ROFL)	Understand	**Understanding Life Skills:** Movie based learning – **Pursuit of Happyness.** What are the skills and values you can identify, what can you relate to?	Interactive learning	3 hours
			Introduction to life skills What are the critical life skills	Activity and Video	1 hour
			Multiple Intelligences Embracing diversity – Activity on appreciation of diversity	Video and activity based	1 hour
	Apply the life skills to different situations	Apply	**Life skill:** Community service – work with an NGO and make a presentation	Field work: Formative Evaluation	10 hours
			Life skill: Join a trek – Values to be learned: Leadership, teamwork, dealing with ambiguity, managing stress, motivating people, creativity, result orientation	Field work: Formative Evaluation	12 hours
				TOTAL	**65 hours**

	Summative Evaluation	**Bloom's Level**	**Type of Assessment**	**Marks**	**Total**
		Understand	Knowledge Test	20 marks	**50 marks**
		Apply	Project (to be evaluated by TCS)	20 marks	
		Apply	Group discussion (to be evaluated by TCS)	10 marks	

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Semester 1

Induction Program (Non Credit)

(To be Finalised by Respective Institute)

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Semester 2

TCS

Computer Science & Business Systems

Semester 2 Curriculum

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Semester 2

LINEAR ALGEBRA

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

Note:
Assignments & tutorials covering the following: Vectors and linear combinations, Matrices, Linear transformations, Complete solution to Ax = b, Determinants, Eigenvalues and Eigenvectors

Text Books:

1. *Higher Engineering Mathematics*, B. S. Grewal, Khanna Publishers.

Reference Books:

1. *Advanced Engineering Mathematics*, (Seventh Edition), Peter V. O'Neil, Cengage Learning.
2. *Advanced Engineering Mathematics*, (Second Edition), Michael. D. Greenberg, Pearson.
3. *Introduction to linear algebra*, (Fifth Edition), Gilbert Strang, Wellesley-Cambridge Press.
4. *Applied Mathematics* (Vol. I & II), P. N. Wartikar & J. N. Wartikar, Pune Vidyarthi Griha Prakashan.
5. *Digital Image Processing*, R C Gonzalez and R E Woods, Pearson.
6. https://machinelearningmastery.com/introduction-matrices-machine-learning/

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Semester 2

STATISTICAL METHODS + Lab

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

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

Data Source:

- www.rbi.org.in

Text Books:

1. *Probability and Statistics for Engineers* (Fourth Edition), I.R. Miller, J.E. Freund and R. Johnson, Prentice Hall India Learning Private Limited.
2. *Fundamentals of Statistics* (vol. I & vol. II), A. Goon, M. Gupta and B. Dasgupta, World Press.

3. *The Analysis of Time Series: An Introduction*, Chris Chatfield, Chapman & Hall/CRC.

Reference Books:

1. *Introduction to Linear Regression Analysis,* D.C. Montgomery and E. Peck, Wiley-Interscience.
2. *Introduction to the Theory of Statistics*, A.M. Mood, F. A. Graybill and D.C. Boes, McGraw Hill.
3. *Applied Regression Analysis*, N. Draper and H. Smith, Wiley-Interscience.
4. *Hands-on Programming with R,* Garrett Grolemund, O′Reilly.
5. *R for Everyone: Advanced Analytics and Graphics,* Jared P. Lander, Addison-Wesley Professional.

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Semester 2

DATA STRUCTURES AND ALGORITHMS (PCC-CS301) + Lab

Basic Terminologies and Introduction to Algorithm & Data Organisation: Algorithm specification, Recursion, Performance analysis, Asymptotic Notation - The Big-O, Omega and Theta notation, Programming Style, 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: Trees (Binary Tree, Threaded Binary Tree, Binary Search Tree, B & B+ Tree, AVL Tree, Splay Tree) and Graphs (Directed, Undirected), Various Representations, Operations & Applications of Non-Linear Data Structures

Searching and Sorting on Various Data Structures: Sequential Search, Binary Search, Comparison Trees, Breadth First Search, Depth First Search Insertion Sort, Selection Sort, Shell Sort, Divide and Conquer Sort, Merge Sort, Quick Sort, Heapsort, Introduction to Hashing

File: Organisation (Sequential, Direct, Indexed Sequential, Hashed) and various types of accessing schemes.

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

Laboratory

1. Towers of Hanoi using user defined stacks.
2. Reading, writing, and addition of polynomials.
3. Line editors with line count, word count showing on the screen.
4. Trees with all operations.
5. All graph algorithms.
6. Saving / retrieving non-linear data structure in/from a file

Text Books:

1. *Fundamentals of Data Structures*, E. Horowitz, S. Sahni, S. A-Freed, Universities Press.
2. *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. *Introduction to Algorithms, Thomas*, H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, The MIT Press.

3. *Open Data Structures: An Introduction (Open Paths to Enriched Learning)*, (Thirty First Edition), Pat Morin, UBC Press.

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Semester 2

PRINCIPLES OF ELECTRONICS ENGINEERING + Lab

Semiconductors: Crystalline material: Mechanical properties, Energy band theory, Fermi levels; Conductors, Semiconductors & Insulators: electrical properties, band diagrams. Semiconductors: intrinsic & extrinsic, energy band diagram, P&N-type semiconductors, drift & diffusion carriers.

Diodes and Diode Circuits: Formation of P-N junction, energy band diagram, built-in-potential, forward and reverse biased P-N junction, formation of depletion zone, 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.

Bipolar Junction Transistors: Formation of PNP / NPN junctions, energy band diagram; transistor mechanism and principle of transistors, CE, CB, CC configuration, transistor characteristics: cut-off active and saturation mode, transistor action, injection efficiency, base transport factor and current amplification factors for CB and CE modes. Biasing and Bias stability: calculation of stability factor

Field Effect Transistors: 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

Feed Back Amplifier, Oscillators and Operational Amplifiers: Concept (Block diagram), properties, positive and negative feedback, loop gain, open loop gain, feedback factors; topologies of feedback amplifier; effect of feedback on gain, output impedance, input impedance, sensitivities (qualitative), bandwidth stability; effect of positive feedback: instability and oscillation, condition of oscillation, Barkhausen criteria. Introduction to integrated circuits, operational amplified and its terminal properties; Application of operational amplifier; inverting and non-inverting mode of operation, Adders, Subtractors, Constant-gain multiplier, Voltage follower, Comparator, Integrator, Differentiator

Digital Electronics Fundamentals: Difference between analog and digital signals, Logic ICs, half and full adder/subtractor, multiplexers, demultiplexers, flip-flops, shift registers, counters.

Laboratory

1. *Semiconductor Diodes and application,*

2. *Transistor circuits,*

3. *JFET, oscillators and amplifiers.*

Semester II

PRINCIPLES OF ELECTRONICS ENGINEERING + Lab (continued)

Text Books:

1. *Microelectronics Circuits*, Adel S. Sedra and Kenneth Carless Smith, Oxford University Press.
2. *Millman's Integrated Electronics*, Jacob Millman, Christos Halkias, Chetan Parikh, McGraw Hill Education.
3. *Digital Logic & Computer Design,* M. Morris Mano, Pearson

Reference Books:

1. *Electronic Devices and Circuit Theory*, Robert L. Boylestad, Louis Nashelsky.
2. *Solid State Electronic Devices*, 6th Edition, Ben Streetman, Sanjay Banerjee
3. *Electronic Principle*, Albert Paul Malvino.
4. *Electronics Circuits:Discrete & Integrated*, D Schilling C Belove T Apelewicz R Saccardi.
5. *Microelectronics*, Jacob Millman, Arvin Grabel.
6. *Electronics Devices & Circuits*, S. Salivahanan, N. Suresh Kumar, A. Vallavaraj
7. *Electronic Devices & Circuit Theory*, 11th Edition, Robert L. Boylestad, Louis Nashelsky.

FUNDAMENTALS OF ECONOMICS

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

Text Books:

1. *Microeconomics*, Pindyck, Robert S., and Daniel L. Rubinfeld.
2. *Macroeconomics*, Dornbusch, Fischer and Startz.
3. *Economics*, Paul Anthony Samuelson, William D. Nordhaus.

Reference Books:

1. *Intermediate Microeconomics: A Modern Approach*, Hal R, Varian.
2. *Principles of Macroeconomics*, N. Gregory Mankiw.

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Semester 2

Semester II

BUSINESS COMMUNICATION & VALUE SCIENCE – II

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 3 Hrs./Week	Semester Examination: 50 marks	4
Practical: 7 Hrs. / Week	Continuous Assessment: Yes	
Lab: 7 Hrs. / Week	Term Work: 50 marks	

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Semester 2

Course ID:

1.6 (Year 1 Semester 2)

	Leadership Oriented Learning (LOL)	

Nature of Course	Behavioral
Pre requisites	Basic Knowledge of English (verbal and written) Completion of all units from Semester 1

Course Objectives:

1	Develop effective writing, reading, presentation and group discussion skills.
2	Help students identify personality traits and evolve as a better team player.
3	Introduce them to key concepts of a) Morality b) Behavior and beliefs c) Diversity & Inclusion

Course Outcomes:
Upon completion of the course, students shall have ability to:

C2.6.1	Understand tools of structured written communication	[U]
C2.6.2	Use tools of structured written communication	[AP]
C2.6.3	Use electronic/social media to share concepts and ideas	[AP]
C2.6.4	Develop materials to create an identity for an organization dedicated to a social cause	[C]
C2.6.5	Understand the basics of presentation	[U]
C2.6.6	Apply effective techniques to make presentations.	[AP]
C2.6.7	Assess presentations based on given criteria	[E]
C2.6.8	Understand tools for quick reading.	[U]
C2.6.9	Apply the basic concept of speed reading, skimming and scanning.	[AP]
C2.6.10	Identify individual personality types and role in a team.	[U]
C2.6.11	Recognize the concepts of outward behavior and internal behavior	[AP]

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C2.6.12	Understand the basic concepts of Morality and Diversity	[U]
C2.6.13	Create communication material to share concepts and ideas	[C]
C2.6.14	Argue on a topic based on morality and diversity	[E]
C2.6.15	Articulate opinions on a topic with the objective of influencing others	[C]
C2.6.16	Organize an event to generate awareness and get support for a cause	[C]

Course Contents:

- **Identification of common errors in written communication and ways of rectification**
- **Understanding speed reading techniques – Skimming and Scanning**
- **Application of reading and writing skills**
- **Analyzing personality traits and team player style**
- **Understanding the concepts of Morality, Diversity and Inclusion**
- **Application of these concepts**
- **Creation of communication material**
- **Experiencing diversity and organizing events to support inclusion**
- **Assignment – Assimilation of concepts and present them effectively**

	Total Hours:	**61**

Text Books:

	There are no prescribed texts for Semester 2 – there will be handouts and reference links shared.

Reference Books:

1	Guiding Souls : Dialogues on the purpose of life; Dr. A.P.J Abdul Kalam ;Publishing Year-2005; Co-author--Arun Tiwari
2	The Family and the Nation; Dr. A.P.J Abdul Kalam; Publishing year: 2015; Co-author: Acharya Mahapragya
3	The Scientific India: A twenty First Century Guide to the World around Us; Dr. A.P.J Abdul Kalam; Publishing year: 2011; Co-author- Y.S.Rajan
4	Forge Your Future: Candid, Forthright, Inspiring ; Dr. A.P.J Abdul Kalam; Publishing year: 2014
5	Abundance: The Future is Better Than You Think; Peter H. Diamandis and Steven Kotler; Published: 21 Feb, 2012; Publisher: Free Press
6	Start With Why: How Great Leaders Inspire Everyone to Take Action; Simon Sinek; Published: 6 October 2011; Publisher: Penguin

7	Advertising & IMC: Principles and Practice; Sandra Moriarty, Nancy D. Mitchell, William D. Wells; Published: 15 June 2016; Publisher: Pearson Education India

Web References:	
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

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

Assessment Methods & Levels (based on Bloom's Taxonomy)			
Formative assessment (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C1.6.1	Understand	Immersion (interview)	5
C1.6.2	Understand	Create CV	4
C1.6.3	Apply	Group Assignment- Form an NGO	5
C1.6.4	Understand	Group activities	3
C1.6.5	Create	Create and present a street play to articulate and amplify the social cause.	3
Summative Assessment based on End Semester Project			
Bloom's Level			
Understand			50
Apply			

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Semester 2

Analyze	Written Assessment, project and group discussion	

Lesson Plan

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1			Icebreaker. 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.	Group discussion, Practical	60 Minutes
1	Understand tools of structured written communication	Understand	Research on the social cause each group will work for.	Practical (practical)	90 Minutes
1	Use tools of structured written communication	Understand	Class discussion- Good and Bad Writing. Common errors, punctuation rules, use of words.	PPT, Theory and Practical	90 Minutes
			Group Practical – As a group, they will work on the social		

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1			issue identified by them. Research, read and generate a report based on the findings. (Apply the learning and recap from the session)	Formative evaluation	70 Minutes
1	Create communication material to share concepts and ideas	Create	**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.	Practical (Practical)	120 Minutes
1	Understand tools for Lucid writing	Understand	Lucid Writing: Encourage the students to go through the links given about Catherine Morris and Joanie Mcmahon's writing techniques.	Theory and Discussion	30 mins
1	Create communication material to share concepts and ideas	Create	Create the magazine	Practical (Lab)	90 Minutes
1		Understand	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.	Theory/Discussion	60 Minutes

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Semester 2

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1	Use electronic/social media to share concepts and ideas	Apply	Launching an E Magazine.	Practical (Lab)	120 Minutes
1			**Quiz Time**	Summative Evaluation for Unit	60 Minutes
Unit 2					
2	Develop materials to create an identity for an organization dedicated to a social cause	Create	Each group will form an NGO. Create Vision, Mission, Value statement, tagline and Design a logo.	Practical and Practical	90 Minutes
2	Understand the basics of presentation	Understand	Introduction to basic presentation skills & ORAI app	Theory and video	60 Minutes
2	Apply effective techniques to make presentations.	Apply	Groups to present their NGOs. Apply the learning gathered from session 2. Presentation to be recorded by the groups. feedback from the audience/ Professor	Formative evaluation	60 Minutes
2	Assess presentation based on given criteria	Evaluate	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	Sharing of learning, written Practical and formative evaluation	60 Minutes & 60 Minutes
2	Create communication material to	Create	Prepare and publish the Second episode of the E Magazine.		

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	share concepts and ideas Use electronic/social media to share concepts and ideas	Apply		Practical (Lab)	120 minutes
2	Understand the tools for speed reading. Apply the basic concepts of speed reading, skimming and scanning.	Understand Apply	Speed Reading session: Introduction to skimming and scanning; practice the same.	Theory and Practical	30 Minutes
2		Understand	SATORI – Join the dots-Participants to connect their learning gathered from AIP Unit-2 with their existing curriculum	Share the most important learning points	60 Minutes
2			**Quiz Time**	Summative Evaluation for Unit	60 Minutes
Unit 3					
3	Develop materials to create an identity for an organization dedicated to a social cause	Create	Ad campaign- Brain storming session- Students to discuss and explore the means of articulating and amplifying the	Discussion	60 Minutes

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			social issue their NGOs are working for.		
3	Create communication material to share concepts and ideas.	Create	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.	Practical based learning. Formative evaluation by Theory	a) 30 Minutes b) 60 Minutes
3	Use electronic/social media to share concepts and ideas	Apply Apply	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.	Practical based learning Formative Evaluation	Lab Time: 90 Minutes Class Time:60 Minutes
3	Identify individual personality types and role in a team.	Understand	(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.	Discussion and Theory	60 Minutes
3	Identify individual personality types and role in a team.	Understand	Cont. (3) Belbin's 8 Team Roles and Lindgren's Big 5 personality traits.(4) Belbin's 8 team player styles	Practical based learning followed by a presentation	40 Minutes
	Identify individual				

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
3	personality types and role in a team.	Understand	(1) Team Falcon Practical to identify individual personality traits with Belbin's 8 team player styles	Practical based learning followed by a presentation.	(1 &2) 40 Minutes
3	Recognize the concepts of outward behavior and internal behavior	Understand	(2) Similar personality types to form groups (3) Groups present their traits.	Presentation	(3) 60 minutes
3	Create communication material to share concepts and ideas. Use the electronic/social media to share concepts and ideas	Create Apply	Prepare and publish the third episode of the E Magazine.	Practical	60 Minutes
3		Understand Understand	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	Share the most important learning points from the activities done so far. Participants talk about the changes they perceive in themselves	60 Minutes
3			**Quiz Time**	Summative Evaluation for Unit	60 Minutes
Unit 4					
	Understand the basic concepts		Ten minutes of your time – a short film on diversity. Play		

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
4	of Morality and Diversity	Understand	the video (link to be attached in the FG)	Video & discussion	30 Minutes
4	Understand the basic concepts of Morality and Diversity	Understand	Discuss key take away of the film. Theory to connect the key take away of the film to the concept of empathy.	Practical	30 Minutes
4	Understand the basic concepts of Morality and Diversity	Understand	Touch the target (Blind man) - Debriefing of the Practical. Film: "The fish and I'' by Babak Habibifar" (1.37mins)	Practical and discussion	60 Minutes
4	Create communication material to share concepts.	Create	Groups to create a story – 10 minutes of a person's life affected by the social issue groups are working on. Narrate the story in first person. Feedbacks to be shared by the other groups.	Practical, sharing and Practical	120 Minutes
4	Understand the basic concepts of Morality and Diversity	Understand	Research on a book, incident or film based on the topic of your respective NGO	Research and written Practical	120 Minutes
4	Create communication material to share concepts.	Create	Write a review in a blog on the topics they are covering in their research. Theory will give grades to each team.	Written Practical and Formative Evaluation	60 Minutes

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
4	Understand the basic concepts of Morality and Diversity	Understand	Session on Diversity & Inclusion- Different forms of Diversity in our society.	PPT, Theory, discussion	60 Minutes
4	Create communication material to share concepts.	Create	Teams to video record interviews of people from diverse groups (Ask 5 questions). Share the recordings in FB	Practical	120 Minutes
4	Argue on a topic based on morality and diversity	Evaluate	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.	Practical and formative evaluation	60 Minutes
4	Articulate opinions on a topic with the objective of influencing others	Create	Prepared speech- Every student will narrate the challenges faced by a member of a diverse group in 4 minutes (speech in first person). Theory to give feedback to each student.	Practical and formative Evaluation	90 Minutes
4	Understand the basic concepts of Morality and Diversity	Understand	Discussion on TCS values, Respect for Individual and Integrity.	PPT, Theory, Practical and discussion	60 Minutes
4	Create communication material to share concepts and ideas.	Create Apply	Prepare and publish the final episode of the E Magazine.	Practical	120 Minutes

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Semester 2

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	Use the electronic/social media to share concepts and ideas				
4		Understand	SATORI –Participants share the personal take away acquired from working in teams, GD, learning about presentations and understanding diversity inclusion.	Discussion	60 Minutes
4	Use tools of structured written communication	Apply	**Revisit your resume** Include your recent achievements in your resume.	Submit it to the Professor	Lab time-30 Minutes
4			**Quiz Time**	Summative Evaluation for Unit	60 Minutes
4	Organize an event to generate awareness and get support for a cause	Create	**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. 2) Spend **a day with the NGO/ social group** to understand exactly how they work and the challenges they face. 3) Render voluntary service to the group for one day 4) Invite the NGO/ social group to address their university students for couple of hours. Plan the entire event, decide a	Field work: Formative Evaluation	7 Hours

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			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 5) The groups to present their experience of **a day with the NGO** and inspire students to work for the cause.		
TOTAL					**61 hours**
	Assessment	Understand	Written Assessment of 20 marks		
		Create	Project of 20 marks (E-Magazine 4 editions)		
		Analyze, Create	Focus Group Discussion 10 marks		

ENVIRONMENTAL SCIENCES (Non-Credit)

(To be Finalised by Respective Institute)

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Semester 3

TCS

Computer Science & Business Systems

Semester 3 Curriculum

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Semester 3

FORMAL LANGUAGE & AUTOMATA THEORY (PCC-CS502)

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, TMs as 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.

Text Books:

1. *Introduction to Automata Theory, Languages, and Computation* John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman.

Reference Books:

1. *Elements of the Theory of Computation,* Harry R. Lewis and Christos H. Papadimitriou.
2. *Automata and Computability,* Dexter C. Kozen.
3. *Introduction to the Theory of Computation,* Michael Sipser.
4. *Introduction to Languages and the Theory of Computation,* John Martin.

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Semester 3

5. *Computers and Intractability: A Guide to the Theory of NP Completeness,* M. R. Garey and D. S. Johnson.

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Semester 3

COMPUTER ORGANIZATION & ARCHITECHTURE (PCC-CS 402)

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.

Text Books:

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

Reference Books:

1. *Computer Architecture and Organization*, John P. Hayes.
2. *Computer Organization and Architecture: Designing for Performance*, William Stallings.

3. *Computer System Design and Architecture*, Vincent P. Heuring and Harry F. Jordan.

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Semester 3

OBJECT ORIENTED PROGRAMMING (PCC-CS503) + Lab

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, #define constant vs const, 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

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:

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Semester 3

1. *Programming – Principles and Practice Using C++*, Bjarne Stroustrup, Addison Wesley.
2. *The Design and Evolution of C++*, Bjarne Stroustrup, Addison Wesley.

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Semester 3

COMPUTATIONAL STATISTICS + Lab

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

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, multi variate regression, cluster analysis with various algorithms, factor analysis, PCA and linear discriminant analysis. Various datasets should be used for each topic

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.*

Semester III

COMPUTATIONAL STATISTICS + **Lab** (continued)

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.

SOFTWARE ENGINEERING + Lab

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

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.

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Semester 3

Semester III

SOFTWARE ENGINEERING + Lab (continued)

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

INDIAN CONSTITUTION (Non Credit)

(To be finalised by Respective Institute)

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Semester 4

TCS

Computer Science & Business Systems

Semester 4 Curriculum

OPERATING SYSTEMS (PCC-CS-403) + Lab (Unix)

Introduction: Concept of Operating Systems (OS), Generations of OS, Types of OS, OS Services, Interrupt handling and System Calls, Basic architectural concepts of an OS, Concept of Virtual Machine, Resource Manager view, process view and hierarchical view of an OS.

Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching.

Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads.

Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time.

Scheduling algorithms: Pre-emptive and non-pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling: Real Time scheduling: RM and EDF.

Inter-process Communication: Concurrent processes, precedence graphs, Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Semaphores, Strict Alternation, Peterson's Solution, The Producer / Consumer Problem, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem, Barber's shop problem.

Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.

Concurrent Programming: Critical region, conditional critical region, monitors, concurrent languages, communicating sequential process (CSP); Deadlocks - prevention, avoidance, detection and recovery.

Memory Management: Basic concept, Logical and Physical address maps, Memory allocation: Contiguous Memory allocation – Fixed and variable partition– Internal and External fragmentation and Compaction.

Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page allocation, Partitioning, Paging, Page fault, Working Set, Segmentation, Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).

I/O Hardware: I/O devices, Device controllers, Direct Memory Access, Principles of I/O.

File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance.

Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks.

Case study: UNIX OS file system, shell, filters, shell programming, programming with the standard I/O, UNIX system calls.

Text Books:

1. *Operating System Concepts Essentials.* Abraham Silberschatz, Peter Baer Galvin and Greg Gagne.

Reference Books:

1. *Operating Systems: Internals and Design Principles*. William Stallings.
2. *Operating System: A Design-oriented Approach*. Charles Patrick Crowley.
3. *Operating Systems: A Modern Perspective*. Gary J. Nutt.
4. *Design of the Unix Operating Systems*. Maurice J. Bach.
5. *Understanding the Linux Kernel*, Daniel Pierre Bovet, Marco Cesati.

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Semester 4

DATATBASE MANGEMENT SYSTEMS (PCC-CS503) + Lab

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.

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.

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Semester 4

SOFTWARE DESIGN EITH UML + Lab

Introduction to on 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.
- Physical Aspect.
- Logical Aspect.
- Connections and Dependencies.
- User face.
- Initial DB design in a UML environment.

Deployment Model.
- Processors.
- Connections.
- Components.
- Tasks.
- Threads.
- Signals and Events.

Text Books:
1. *Object-Oriented Software Engineering: using UML, Patterns, and Java.* Bernd Bruegge and Allen H. Dutoit.

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Reference Books:

1. *Design Patterns: Elements of Reusable Object-Oriented Software*. Erich Gamma, Richard Helm, Ralph Johnson, and John M. Vlissides.

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Semester 4

Introduction to Innovation, IP Management & Entrepreneurship

Course ID:

2.2.4 (Year 2 Semester 2)

Course Pre Requisite(s):

Good knowledge of Fundamentals of Management (Covered in Year 2, Semester 1)

Course Outcome(s):

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.

As a part of this course, students will:

- Learn to be familiar with creative and innovative thinking styles
- Learn to investigate, understand and internalize the process of founding a startup
- Learn to manage various types of IPR to protect competitive advantage

Topics to Be Covered:

UNIT – I

Innovation: What and Why?

Innovation as a core business process, Sources of innovation, Knowledge push vs. need pull innovations.

Class Discussion- Is innovation manageable or just a random gambling activity?

UNIT – II

Building an Innovative Organization

Creating new products and services, Exploiting open innovation and collaboration, Use of innovation for starting a new venture

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Class Discussion- Innovation: Co-operating across networks vs. 'go-it-alone' approach

UNIT – III

Entrepreneurship:

- Opportunity recognition and entry strategies
- Entrepreneurship as a Style of Management
- Maintaining Competitive Advantage- Use of IPR to protect Innovation

UNIT – IV

Entrepreneurship- Financial Planning:

- Financial Projections and Valuation
- Stages of financing
- Debt, Venture Capital and other forms of Financing

UNIT – V

Intellectual Property Rights (IPR)

- Introduction and the economics behind development of IPR: Business Perspective
- IPR in India – Genesis and Development
- International Context
- Concept of IP Management, Use in marketing

UNIT – VI

Types of Intellectual Property

- Patent- Procedure, Licensing and Assignment, Infringement and Penalty
- Trademark- Use in marketing, example of trademarks- Domain name
- Geographical Indications- What is GI, Why protect them?
- Copyright- What is copyright
- Industrial Designs- What is design? How to protect?

Class Discussion- Major Court battles regarding violation of patents between corporate companies

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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 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. Instructor can add or change any topic as per requirement.

Topic 1- Is innovation manageable or just a random gambling activity?

Topic 2- Innovation: Co-operating across networks vs. 'go-it-alone' approach

Topic 3- Major Court battles regarding violation of patents between corporate companies

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

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Semester 4

Business Communication & Value Science 3

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 2.5 Hrs./Week	**Semester Examination: 50 marks**	**4**
Practical: 1.5 Hrs. / Week	**Continuous Assessment: Yes**	
Lab: 2 Hrs. / Week	**Term Work: 50 marks**	

Course ID:

1.6 (Year 2 Semester 4)

	Leadership Oriented Learning (LOL)	

Nature of Course	Behavioral
Pre requisites	Basic Knowledge of English (verbal and written) Completion of all units from Semesters 1, 2 and 3

Course Objectives:	
1	Develop technical writing skills
2	Introduce students to Self-analysis techniques like SWOT & TOWS
3	Introduce students to key concepts of: a) Pluralism & cultural spaces b) Cross-cultural communication c) Science of Nation building

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Course Outcomes:

Upon completion of the course, students shall have ability to

C2.6.1	Apply & analyze the basic principles of SWOT & life positions.	[U]
C2.6.2	Understand, analyze & leverage the power of motivation in real life	[AP]
C2.6.3	Identify & respect pluralism in cultural spaces	[AP]
C2.6.4	Understand and apply the concepts of Global, glocal and translocational	[C]
C2.6.5	Analyze cross cultural communication	[U]
C2.6.6	Apply the science of Nation building	[AP]
C2.6.7	Identify the common mistakes made in cross-cultural communication	[E]
C2.6.8	Understand, apply & analyze the tools of technical writing	[U]
C2.6.9	Recognize the roles and relations of different genders.	[AP]
C2.6.10	Understand Artificial intelligence &recognize its impact in daily life	[U]
C2.6.11	Identify the best practices of technical writing	[AP]
C2.6.12	Differentiate between the diverse culture of India	[E]

Course Contents:

Objectives for Semester 4

After completing this semester, learners will be able to:

- Summarize the basic principles of SWOT and Life Positions.
- Apply SWOT in real life scenarios.
- Recognize how motivation helps real life.
- Leverage motivation in real-life scenarios.
- Identify pluralism in cultural spaces.
- Respect pluralism in cultural spaces.
- Differentiate between the different cultures of India.
- Define the terms global, glocal and translocational.
- Differentiate between global, glocal and translocational culture.
- Recognize the implications of cross-cultural communication.
- Identify the common mistakes made in cross-cultural communication.

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- Apply cross-cultural communication.
- Differentiate between the roles and relations of different genders.
- Summarize the role of science in nation building.
- Define AI (artificial intelligence).
- Recognize the importance of AI.
- Identify the best practices of technical writing.
- Apply technical writing in real-life scenarios.

	Total Hours:	
		48 hours

Text Books:

	There are no prescribed texts for Semester 4 – there will be handouts and reference links shared.

Reference Books:

1	
2	
3	
4	

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

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C1.6.1	Analyze	SWOT in real life	5
C1.6.2	Analyze	Motivation in real life	4

Summative Assessment based on End Semester Project

Bloom's Level		
Understand	Written Assessment, project and group discussion	50
Apply		
Analyze		

Lesson Plan

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Guest lecture by a renowned personality to kick start this semester.	This will be outside the total hours for this Semester	**90 mins**
1			REUNION	Activity	

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Recap activity on the earlier learning after a 6 months break. If we can flash the projects they completed in the last semester…… End with a Quiz in multiple format rounds testing the objectives.		60 Minutes
1	**Summarize the basic principles of SWOT and Life Positions.**	2	SWOT and Life Positions Meet Dananjaya: Meet Dananjaya Hettiarachchi The World Champion of Public Speaking 2014 who made the winning speech which was rated amongst the "Most talked-about speeches of 2014". https://www.youtube.com/watch?v=bbz2boNSeL0&t=24s Debrief on the video. How it relates to SWOT. **Intro activity**: Give story of an individual* and divide people into 4 groups S W O T and ask them to jot down the SWOT. Start with a different nomenclature (demystifying SWOT)	Lecture and activity	60 Minutes

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1	Apply SWOT in real life scenarios.	3	Pat your back activity…strength will be written by others other points by you Create your SWOT	Practical	60 Minutes
1	Apply SWOT in real life scenarios.	3	SWOT Vs. TOWS The Balancing Act Ted talk on biomimicry: (Only first 8 mins): https://www.youtube.com/watch?v=RHrO4t86phA Debrief on the Ted talk in which the facilitator gently guides the group towards the understanding that survival happens only when we seek ideas from the external world to turn the threat into opportunity Research on TOWS and find out how you can turn your threat into opportunity. Two people mutually identifying opportunities from each other's threats.	Lab	120 minutes
1	Apply SWOT in real life scenarios.	3	Presentation on what are the strengths they have identified to survive in the VUCA World.	Formative evaluation	90 mins

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Group presentations of 10 mins each.		
1	Recognize how motivation helps real life.	1	Motivation Stories YouTube videos on Maslow's Theory	Lecture and activity	90 mins
1	Leverage motivation in real-life scenarios.	3	Scenario based activity on identifying and leveraging motivation	Formative evaluation/Lab	60 mins
1	Recognize how motivation helps real life.	1	Present their findings and approaches as groups. They need to explain the idea of motivation with the help of examples.	Practical	60 mins
Unit 2					
2	Identify pluralism in cultural spaces.	1	Rivers of India a. Divide participants into groups of 5. Each group should assign themselves a name from the Indian Rivers. These groups will continue throughout this Unit. b. Learn and Exchange Group activity in which participants need to learn the following four greetings of a state (different from their own) and exchange it with another group: • Good morning	Activity	90 Minutes

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			• Thank you • Sorry • Good night Indicative only		
2	Identify pluralism in cultural spaces. Respect pluralism in cultural spaces.	2 3	a. Awareness and respect for pluralism in cultural spaces b. Announce the Rhythms of India activity to be held in the next session. The rules of the activity will be detailed at this point. Teams to prepare for the performance beyond class hours.	Theory/Discussion using Phir Miley Sur Mera Tumhara	90 Minutes
2	Differentiate between the different cultures of India.	2	Rhythms of India (Cultures in India) Group activity: Each group to perform a short dance piece (3 mins) from any of the Indian states (to be decided by lots). They have to present the background and unique features of the dance form (5 min).	Practical/Discussion	120 Minutes
2	• Define the terms global, glocal and translocational. • Differentiate between global, glocal and translocational culture.	1, 2	a. Global, glocal, translocational Use Ted and YouTube videos to show examples b. Announce debate to be held in the next session. They have to come prepared for the debate/discussion.	Lecture/Discussion	60 mins

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
2	Differentiate between global, glocal and translocational culture.	2	Debate on Global, glocal, tanslocational impacts (topics to be decided by the faculty or suggested by the students). Debate to be held in the presence of an external moderator. Eight groups will get four topics to debate upon.	Activity	60 mins
2	• Recognize the implications of cross-cultural communication. • Identify the common mistakes made in cross-cultural communication.	1, 2	Cross-cultural communication A. Verbal and non-verbal communication (approach is through videos). Point out the obvious mistakes. From our perspective…how anyone would feel if someone else made mistakes about our cultures. B. Let participants have a group discussion on the implications of cross cultural communication.	Lecture/Discussion	60 mins
2	Apply cross cultural communication.	3	Suggested long-term activity: A VR game in which learners can visit different locations of the world and overcome challenges by using cross cultural skills.		
2	Identify the common mistakes made in cross-cultural communication	2	Culture shock Group activity to perform skits based on situations provided by the lecturer.	Practical	60 mins

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
2	Differentiate between the roles and relations of different genders.	2	Gender awareness Participants will view relevant scenarios in the class and then participate in a reflection activity in group. The scenarios can be presented using an Augmented Reality intervention.	Discussion	90 mins
2	Differentiate between the roles and relations of different genders.	2	Gender awareness campaign Groups to present the detailed plan of Gender awareness campaigns with four different themes. • College • Workplace • Family • Friends	Activity	60 mins
2			Quiz Time	Summative Evaluation for Unit	60 Minutes
Unit 3					
3	Summarize the role of science in nation building.	2	Role of science in nation building Introduce the topic and discuss the role of scientists and mathematicians from ancient India. Break the students into groups and give them ten minutes to access internet and get information about ten	Theory and lab	90 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			eminent scientists and mathematicians of ancient India. Groups will be given five minutes to present on the next day. Groups will also frame two questions which they will ask after presenting. This can also be taught through Augmented Reality, where images of the scientists will be put up around the class and they will be able to gather the information by using their phones and AR app.		
			Groups present their findings. Other groups note down their learning. At the end there will be a quiz to assess their learning.	Activity	90 mins
	Summarize the role of science in nation building.	2	Role of science post-independence Groups to present using multiple formats on any one of the four given topics. • Inventions • Inventors • Institutes • Information technology	Lab and practical	120 mins

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	Identify the best practices of technical writing.	1	Introduction to technical writing Basic rules of technical writing through examples.	Lecture (Guest faculty, over webinar)	60 mins
	Identify the best practices of technical writing.	1	Practice activity on technical writing.	Lab	60 mins
	Apply technical writing in real-life scenarios.	3	Assessment on technical writing on the following topic: Explain the following to a visually impaired person: • DNA • Rings of Saturn • Structure of an oxygen atom • Structure of heart	Summative evaluation	60 mins
Unit 4					
4	Define AI (artificial intelligence).	1	"Voice of the Future" Activity How will a voice assistant evolve in 25 years from now? Each group will present a skit.	Activity	90 mins
	Recognize the importance of AI.	1	AI in Everyday Life Discussion in groups on given topics and then cross sharing of discussion points amongst the groups.	Lab and Activity	90 mins

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	Recognize the importance of AI.	1	Design your college in the year 2090 Groups need to create the college of future with the future teachers, teaching methods, types of students, etc. We will end the session with the question: How will offices/workplaces change in future? Who do you think would be your colleagues?	Lab and Practical	90 mins
	Recognize the importance of AI.	1	Communicating with machines Theory and Ted talk videos	Lecture	60 mins
	Recognize the importance of AI.	1	Debate in the presence of an external moderator. Will machines control us in future?	Discussion	90 mins
	Identify the best practices of technical writing.	1	Applying technical writing in profession Theory with YouTube and Dr Bimal Ray's videos. Dr Bimal Kumar Roy, a former Director of the Indian Statistical Institute, is a cryptologist from the Cryptology Research Group of the Applied Statistics Unit of ISI, Kolkata.	Lecture	90 mins

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
	Apply technical writing in real-life scenarios.	3	Scenario-based Assessment on technical writing Each group will make a presentation on the following: a) Sell Analytics and Insight to the local tea seller. b) Explain the concept of Cloud to your 87 year old grandmother. c) Introduce the concept of friendly robots to a class 3 kid. Explain IOT to your helping hand at home	Summative evaluation	60 mins
Project					
			Visit rural area/ underprivileged parts of city to address some of the local issues; if relevant, suggest a practical technology solution to the issues.	Project	10 hours

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Semester 4

Operations Research + Lab

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.
Some basic concepts and results of linear algebra – Vectors, Matrices, Linear Independence / Dependence of vectors, Rank, Basis, System of linear eqns., 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, types), Fixed order-quantity models – EOQ, POQ & Quantity discount models. EOQ models for discrete units, sensitivity analysis and Robustness, Special cases of EOQ models for safety stock with known / unknown stock out situations, models under prescribed policy, Probabilistic situations.

Operations Research + Lab (continued)

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 – clock, event list, Application in Scheduling, Queuing systems and Inventory systems.

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.

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Semester 4

Essence of Indian Traditional Knowledge (Non Credit)

(**To be finalised by Respective Institute**)

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Semester 5

TCS

Computer Science & Business Systems

Semester 5 Curriculum

DESIGN AND ANALYSIS OF ALGORITHMS (PCC-CS 404) + Lab

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.

Lab

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

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.

Quantum Computation and Quantum Information, Michael A. Nielsen and Isaac L. Chuang.

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Semester 5

COMPILER DESIGN (PCC-CS 601) + Lab (LEX & YACC)

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.

Lab

Assignments using Lex and Yaac

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:

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

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Semester 5

FUNDAMENTALS OF MANAGEMENT

Course Outcome(s):

This course will teach students the management theories, evolution of management over the years and few basic concepts without going into the details. After studying this course the students will develop an understanding about how organizations work and find it easier to grasp the intricacies of other management areas such as finance, marketing, strategy etc. which will be taken up in future terms.

Topics to Be Covered:

UNIT – I

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.

UNIT – II

Functions of Management- Planning, Organizing, Staffing, Directing, Controlling

UNIT – III

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

UNIT – IV

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

UNIT – V

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

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Semester 5

UNIT – VI

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. Instructor can add or change any topic as per requirement.

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! The debate

Text Books:

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

Reference Books:

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

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Semester 5

BUSINESS STRATEGY

Course Outcome(s):

This course will help students,

- To learn the fundamental concepts of strategic management to analyze business situations and apply these concepts to solve business problems.
- To understand the fundamental principles of and interrelationships among business functions such as: R&D, production, marketing, finance, HR and information technology
- To understand the inter-relationships of business to individuals, other organizations, government and society.
- To analyze complex, unstructured qualitative and quantitative problems, using appropriate tools.

Topics to Be Covered:

UNIT – I

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

UNIT – II

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

UNIT – III

External Environments of Firm- Competitive Strategy

- Five Forces of Industry Attractiveness that Shape Strategy

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Semester 5

- The concept of Strategic Groups, and Industry Life Cycle
- Generic Strategies
- Generic Strategies and the Value Chain

UNIT – IV

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

UNIT – V

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.

Text Books:

1. Robert M. Grant (2012). *Contemporary Strategic Management*, Blackwell, 7th Edition.

Reference Books:

1. M.E. Porter, *Competitive Strategy*, 1980. M.E. Porter,
2. *Competitive Advantage*, 1985 Richard Rumelt (2011).

Good Strategy Bad Strategy: The Difference and Why It Matters.

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Semester 5

DESIGN THINKING

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Semester 5

CONVERSATIONAL SYSTEMS + Lab (Elective I)

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Semester 5

CLOUD, MICROSERVICES & APPLICATION + Lab (Elective I)

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Semester 5

MACHINE LEARNING + Lab (Elective I)

Topics to Be Covered:

1. 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
2. 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
3. Hidden Markov Models (HMM) with forward-backward and Vierbi algorithms; Sequence classification using HMM; Conditional random fields; Applications of sequence classification such as part-of-speech tagging
4. Regression: Multi-variable regression; Model evaluation; Least squares regression; Regularization; LASSO; Applications of regression
5. Association rule mining algorithms including apriori
6. Expectation-Maximization (EM) algorithm for unsupervised learning
7. Clustering: average linkage; Ward's algorithm; Minimum spanning tree clustering; K-nearest neighbors clustering; BIRCH; CURE; DBSCAN
8. Anomaly and outlier detection methods

Lab Sessions:

(1) Introduction to WEKA and R
(2) Classification of some public domain datasets in UCI ML repository

Mini projects in the Lab:
(1) Implementation of one clustering algorithm
(3) Implementation of one association rule mining algorithm
(4) Implementation of one anomaly detection algorithms
(5) Implementation of EM algorithm for some specific problem

References:
[1] R.O. Duda, P.E. Hart, D.G. Stork, **Pattern Classification**, 2/e, Wiley, 2001.
[2] C. Bishop, **Pattern Recognition and Machine Learning**, Springer, 2007.
[3] E. Alpaydin, **Introduction to Machine Learning**, 3/e, Prentice-Hall, 2014.
[4] A. Rostamizadeh, A. Talwalkar, M. Mohri, **Foundations of Machine Learning**, MIT Press.
[5] A. Webb, **Statistical Pattern Recognition**, 3/e, Wiley, 2011.

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Semester 6

TCS

Computer Science & Business Systems

Semester 6 Curriculum

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Semester 6

COMPUTER NETWORKS + LAB

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.

Computer Networks Lab

1. Socket Programming using C/C++
2. Network System Administration: Understanding switches and routers

Books:

1. *Computer Networks*, A. Tannenbaum.
2. *Data and Computer Communication*, William Stallings.

Reference Books:

3. *Network Security*, Kaufman, R. Perlman and M. Speciner.
4. *UNIX Network Programming*, Vol. 1,2 & 3, W. Richard Stevens

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Semester 6

INFORMATION SECURITY + LAB

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.

Lab

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

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:

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

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Semester 6

ARTIFICIAL INTELLIGENCE + LAB

Course Outcome(s):

This course introduces students to the basic knowledge representation, problem solving, and learning methods of artificial intelligence.

Topics to Be Covered:

UNIT – I

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.

UNIT – II

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

UNIT – III

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

UNIT – IV

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.

UNIT – V

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.

UNIT – VI

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.

UNIT – VII

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

Home Assignments:

Assignments should include problems related to the topics covered in lectures, like heuristics, optimal search, and graph heuristics. Constraint satisfaction problems, k-nearest neighbors, decision trees, etc. can be included in home assignments.

Text Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach
2. Artificial Intelligence, Russel, Pearson

Reference Books:

1. Artificial Intelligence, Ritch & Knight, TMH
2. Introduction to Artificial Intelligence & Expert Systems, Patterson, PHI
3. Logic & Prolog Programming, Saroj Kaushik, New Age International
4. Expert Systems, Giarranto, VIKAS

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Semester 6

FINANCIAL & COST ACCOUNTING

Course Outcome(s):

This course will help students

- To create an awareness about the importance and usefulness of the accounting concepts and their managerial implications
- To develop an understanding of the financial statements and the underlying principles and learn to interpret financial statements
- To create an awareness about cost accounting, different types of costing and cost management

Topics to Be Covered:

UNIT – I

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

UNIT – II

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

UNIT – III

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

UNIT – IV

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

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Semester 6

UNIT – V

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

UNIT – VI

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

Text Books:

1. Robert N Anthony, David Hawkins, Kenneth Marchant, *Accounting: Texts and Cases*, McGraw-Hill
2. Case Study Materials: To be distributed for class discussion

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Semester 6

BUSINESS COMMUNICATION & VALUE SCIENCE – IV

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 5 Hrs./Week	Semester Examination: 50	4
Practical: 2 Hrs. / Week	Continuous Assessment: Yes	
Lab: 1 Hr / Week	Term Work: marks	

	Leadership Oriented Learning (LOL)	

Nature of Course	Behavioral
Pre requisites	Basic Knowledge of English (verbal and written) Completion of all units from Semesters 1, 2, 3, 4 and 5

Course Objectives:

1	Recognize the importance of diversity in workplace
2	Recognize the best practices of communicative writing
3	Understand the importance of emotional intelligence in personal and professional lives
4	Apply emotional intelligence in real life scenarios
5	Use the best practices of public speaking in real life scenarios
6	Understand the importance of corporate social responsibility (CSR)
7	Understand the importance of corporate etiquettes
8	Practice corporate etiquettes in real life scenarios

9	Recognize the best practices to share and receive feedback	
10	Use the basic guidelines required to manage conflicts	
11	Understand how stress impacts life and work	
12	Use the best practices to manage stress	
13	Practice the best time management practices	

Course Outcomes:

Upon completion of the course, students shall have ability to

	Understand the importance of diversity in workplace	[U]
	Apply emotional intelligence in real life scenarios	[AP]
	Recognize the best practices of communicative writing	[AP]
	Understand the importance of corporate social responsibility (CSR)	[C]
	Recognize the importance of time management	[U]
	Apply knowledge of multiple intelligences and learning styles in interpersonal interactions	[AP]
	Recognize the impact of stress in life and work	[E]
	Understand how stress impacts life and work	[U]
	Identify the best practices to manage stress	[AP]
	Recognize the attributes needed to function and grow in a corporate environment	[U]
	Recognize the best practices to share and receive feedback	[AP]
	Identify the best time management practices	[E]

Course Contents:

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Semester 6

Objectives for Semester 6

- Understand the importance of diversity in workplace
- Identify the key aspects of communicative writing
- Apply communicative writing in real life scenarios
- Use charts and graphs in communicative writing
- Understand what is emotional intelligence
- Recognize the importance of emotional intelligence in personal and professional lives
- Understand why you would need public speaking at your workplace
- Identify the best practices of public speaking
- Apply public speaking in real life scenarios
- Recognize the importance of corporate social responsibility (CSR)
- Recognize the importance of corporate social responsibility (CSR)
- Recognize the attributes needed to function and grow in a corporate environment
- Recognize the best practices to share and receive feedback
- Apply emotional intelligence in real life scenarios
- Apply knowledge of multiple intelligences and learning styles in interpersonal interactions
- Recognize the impact of conflicts
- List the basic guidelines required to manage conflicts
- Recognize the key features of corporate etiquette
- Recognize the business idioms and corporate terms
- Apply the business idioms and corporate terms
- Recognize the impact of stress in life and work
- Identify the best practices to manage stress
- Recognize the importance of time management
- Identify the best time management practices

	Total Hours:	
		45 hours 40 hours of must know + 5 hours of nice to know learning
Text Books:		

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Semester 6

	There are no prescribed texts for Semester 6 – 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-humanity-philanthropy-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

Assessment Methods & Levels (based on Bloom's Taxonomy)
Formative assessment (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C1.6.1			5
C1.6.2			4

Summative Assessment based on End Semester Project		
Bloom's Level		

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Semester 6

Understand		
Apply		
Analyze		

Lesson Plan

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1	NA – Recapitulation activity	Recall information	**Auld Lang Syne** This will be a group activity in which lecturer will give some key words (from what they taught in the previous semesters). Each group will identify topics related to the key words and take 2 mins to share a summary of what they learnt in that topic. They can refer to their Satori books and finally note down these key learnings too.	Activity	45 mins
1	Understand the importance of diversity in workplace	2	Introduce the concept of Diversity in corporate environments through an activity.	Activity	45 mins
1	Understand the importance of diversity in workplace	2	Discussion, role plays and sharing reference materials.	Discussion and Practical	60 mins
1	Identify the key aspects of communicative writing	2	**Communicative Writing** • Principles of Communicative Writing • Formal and Business letters	Lecture and practice	90 mins (30 mins lecture + 60 mins practice)

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1	Apply communicative writing in real life scenarios	3	**Writing proposals** This will be taught through a group activity in which students will be asked to create a business proposal to get funding to begin a start-up of their choice. After they share their presentations, lecturer will share the best practices and templates for writing proposals (will be provided to the lecturer as part of the Faculty guide) and ask students to review their proposal and update it. Students should save this proposal for reference later in the sem. Students will have to continue in these groups for the rest of this sem.	Lecture and activity	90 mins
1	Use charts and graphs in communicative writing	3	**How to tell a story with charts and graphs** Session will begin with a couple of demo videos. This will be followed by an activity on how to visually represent information to tell a	Practical	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			complete story. Students will be required to use the proposal for the start-up that they created in the previous class for this.		
1	Understand what is emotional intelligence Recognize the importance of emotional intelligence in personal and professional lives	2	**Emotional Intelligence** Begin with a short video/movie clip showing manifestations of EI. Introduce the concept of EI and give them the experience through a game/activity. Discuss the findings that students with higher EQ write better exam papers. **Ref reading**: 10 Ways to Build EI by Daniel Goleman Ask students to note down the names of at least two movies in their Satori slam book, in which the characters display EI.	Lecture and activity	90 mins
1	Understand why you would need public speaking at your workplace	2	**Why do we need public speaking?** Any two of the YouTube /IncTalks videos: a. Swami Vivekananda's Chicago speech b. Steve Jobs' first iPhone launch	Lecture and discussion	60 mins

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			c. Martin Luther King Jr (I have a dream…) d. J K Rowling commencement speech address 2008 e. APJ Abdul Kalam f. Any regional speakers Professors to ask what is common in these videos and lead them to the concept of public speaking (directions will be provided in the Facilitator's Guide). Session for students to re-visit the group discussion and value proposition sessions that they participated in during the previous semesters. (This will be integrated in the semester 6 content)		
1	Identify the best practices of public speaking		**Public speaking – best practices** Ask each group (formed earlier) to research and come up with a list of best practices along with examples (in the class). After each group presents their list of best practices, students will discuss and create a consolidated list of best practices by considering all common or overlapping ones and map it against the	Activity	60 mins

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			guidelines provided by the TCS team. Additional: Possible guest lecture or webinar (Dr Giri)		
1	Apply public speaking in real life scenarios	3	**Get, Set, Go – sell your start-up ideas** Each group to pitch their start-up idea to a panel consisting of external professors. They will use the presentation they created earlier and the best practices of public speaking to tell their story leveraging the storytelling and doodling methods they learnt in the previous semester (Design Thinking). Their story should at least include: • Name of their start-up • Who is the target audience/end user? • What problem will their start-up solve? • How do they plan to run start up? • How much money/budget would they need to begin their work? Professors to share the results of this formative assessment with the TCS Team so that we can use it for reference in GD post sem.	Formative assessment	120 mins

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Semester 6

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
1	NA		**Let's relax** This will be a short session in which students will participate in at least 2 Anubhaav Activities (to be specified in the Fac Guide).	Activity	45 mins
2	Recognize the importance of corporate social responsibility (CSR)	1	**Corporate Social Responsibility (CSR)** Ubuntu story – A story to introduce the concept of social responsibility. The story will be played through an audio embedded in the PPT (similar to an audiobook).	Lecture	45 mins
2	Recognize some of the stalwarts in CSR	1	**Hear CSR stories** • Meeting of JNT and Swami Vivekananda. • Societal connect of JNT. Stalwarts in CSR (Led by Tatas) • More Tata Group CSR stories --- from Titan and Tata Chemicals Initially, Professors will share any two of the above CSR stories. Thereafter, they will discuss the stories in the class and ask the students to share their thoughts. Lecturer to ask students why they need to conduct CSR	Lecture	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			activities? (Answers will be given in handouts provided by the TATA Team) Why do corporates need to engage in CSR? Is it for compliance only? The answers to these questions (given in the content) will refer back to the topics on TCS values, life skills and empathy taught in the earlier semesters. Lecturer to explain to the students how CSR connects to their values and how CSR activities can add value to their resumes.		
2	Recognize the importance of corporate social responsibility (CSR)	1	**Tell a CSR story** Activity - Groups will research in class, prepare and present CSR activity of Tata Steel, Microsoft, Google, TCS, Starbucks, Titan, Tata Chemicals and TOMS Shoes.	Practice activity	90 mins
2	Recognize the attributes needed to function and grow in a corporate environment	1	**Attributes required for work and life** • Qualities of a good team member: a) Resilience b) Flexibility c) Strategic thinking and planning d) Decision making e) Resolving conflicts	Lecture and discussion	60 mins

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Professors to first show examples and non-examples and then the participants to identify the traits that set them apart.		
	NA		**Let's relax** This will be a short session in which students will participate in at least 2 Anubhaav Activities (to be specified in the Fac Guide).	Activity	45 mins
3	Recognize the attributes needed to function and grow in a corporate environment	1	Activity – **Who am I?** (Image Management. Building a perfect image) This is an individual activity in which each participant needs to reflect upon the following questions (in the order given below) and jot down the answers. They will be given a handout with the questions printed on it for this activity. 1. What do I wish to be seen as? (aspirational state) 2. How do I see myself now? (present state) 3. How others see me? (perceptions)	Activity	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			4. What is the gap between how others see me and how I see myself? 5. How do I fill the gap? Why is it important to fill the gap (connect to importance of personal branding to stay relevant). Professor to share examples of personal branding in the corporate world, as mentioned in the content.		
3	Recognize the best practices to share and receive feedback	1	**Examination Result Activity - Locus of control** (referring back to Emotional intelligence) One person from each group (to be decided through drawing lots) will be asked to step aside to act as teachers. The rest of the group members will participate as students. Each group will be given a scenario in which they will get mock grades in an examination. They will be asked to react to their result. Their reactions will be noted. • Examination Result Activity-Phase II –Role play on feedback.	Activity	90 mins

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Semester 6

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Now the teachers will be asked to have a discussion with each one to two people from each group sharing their feedback on their reactions. After the activity, tips to receive and give feedback will be shared. Handouts will be shared with lecturers.		
3	Apply emotional intelligence in real life scenarios	3	**Applying emotional intelligence** Activity for applying Emotional Intelligence using scenarios within each start-up group. There will be separate scenarios for each group. Professors will judge the groups based on guidelines provided by the TCS team.	Lab Activity	60 mins
	NA		**Let's relax** This will be a short session in which students will participate in at least 2 Anubhaav Activities (to be specified in the Fac Guide).	Activity	45 mins

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Semester 6

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
4	Apply knowledge of multiple intelligences and learning styles in interpersonal interactions	3	**Sensitivity to diversity - Quiz** A scenario-based quiz on (handouts to refresh Sem-1 content on multiple intelligences and learning styles followed by scenario-based quiz) – awareness of multiple intelligences and learning styles in communication. The questions will be based on scenarios that the students might face later in their work environment.	Formative assessment	60 mins
4	Recognize the impact of conflicts		**Understanding conflicts** This will be a group activity. Each group will be given a scenario of typical conflicts that occurs in a corporate office. In each group roles will be assigned to the group members who would be expected to play it. Each group will enact the situation while others watch and note down their observations on: 1. What is the conflict?	Activity	90 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			2. What has caused the conflict? 3. What is the negative impact of the conflict? 4. What can be a positive impact of the conflict? Each group will be requested to draw up a list of tips to manage conflicts at work and share in the next class and post on their Fb/Insta page. They can compare it with handout provided to lecturers. Student needs to reflect upon lessons in empathy and active listening (taught in the previous semesters) while managing conflicts. Each person will be requested to capture at least one Satori moment from these enactments of real-life scenarios.		
4	List the basic guidelines required to manage conflicts	1	**Tips to manage conflicts** Each group will share their list of guidelines to manage conflicts, post which the	Lecture	60 mins

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Semester 6

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			lecturer can share the standard list provided (as a hand-out) and discuss the main points in the class. After that the lecturer will ask them to reflect on what are the changes they need to bring about in their behaviour, based on Belbin's Team Player roles (Sem 2 Unit 3).		
4	Recognize the key features of corporate etiquette	1	**Corporate etiquette** Mock interview rounds for each group with a prospective employer followed by discussions on corporate etiquette (leverage Interview Ready app)	Activity	60 mins
4	Recognize the business idioms and corporate terms Apply the business idioms and corporate terms	1 3	**Business idioms and Corporate Terms** This will begin with a quiz in which in the first four rounds each group needs to identify the business idioms and corporate terms from given excerpts. In the next four rounds they will be asked to supply the correct idiom or term in a given business scenario. After the quiz, the lecturer would share handouts of	Lab activity	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			common business idioms and guide them to download the TCS BizVocab on their smartphones.		
4	Recognize the impact of stress in life and work	1	**Managing Stress** Participants will first watch a short YouTube video: Managing Stress - Brainsmart – BBC (2:24 mins) Then the lecturer will discuss stress and its impact through the following questions: 1. Have you ever felt stressed? 2. What are the situations that make you feel stressed? 3. Does the stress help you in overcoming the situation? 4. Do you know how stress affects your health? After this they will watch a video on how stress impacts health: YouTube: The Long-term Effects of Stress (5 mins) Finally, each group will be asked to create a poster with stress management tips to be	Lecture	60 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			presented in the next class and uploaded on their Fb/Insta pages.		
5	Identify the best practices to manage stress	1	**Tips to manage stress** Each group will present their posters and the class will come up with a list of stress management tips to be put up on the Fb/Insta page. They should also note this in their journals so that they can refer to it whenever they feel stressed.	Discussion Activity	60 mins
	Recognize the importance of time management	1	**Time management** Session begins with an introductory activity that establishes the fact that we often manage time poorly and as a result experience stress. After that participants will watch the YouTube video: Importance of Time Management For Better Life Style (3:33 mins) Now the lecturer will conduct an open house discussion, where the participants will share their challenges to manage time.	Lecture	45 mins

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Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Now the lecturer will ask the participants to evaluate their ability to handle their daily task within 24 hrs on a scale of 10. This is a confidential rating which participants needs to note down in their satori book with date and time for future reference. (this activity will be repeated at a later stage)		
	Identify the best time management practices	1	**Managing your time better** The class will start with the YouTube video: A valuable lesson for a happy life (2:33 mins) After viewing this, the facilitator will ask the participants to identify the rocks, pebbles and sands in their life. This will be followed by the **Time Squared Activity**: Each participant gets 3 pages with 24 squares representing the hours in a day. Participants need to fill out: The **first page** with the everyday activities in their day (example, brushing teeth, bathing, meals, travelling, etc)	Activity	90 mins

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			The **second page** with the non-productive work that they do every day (social media, mobile-games, etc) On the third page they can add everything from the first two pages to find out the empty spaces. That is their productive time when they can study. This gives them a view of what they can adjust in order to increase their study time. Reference video: Study Skills – Managing your time (4:29 mins) Participants to repeat the self-evaluation exercise. In this instant, the participants will evaluate their ability to plan their daily task on a scale of 1 to 10 with date and time. Lecturer to encourage participants to evaluate their time management skills on a regular basis.		
	NA		**Let's relax** This will be a short session in which students will participate in at least 2 Anubhaav Activities (to be specified in the Fac Guide).	Activity	45 mins
		1	**Create memories**		30 mins

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Semester 6

Unit No	Objective	Bloom's Level	Content	Type of Class	Duration
			Recap activity on the entire BCVS Course.		
				Total	**30 hours**
			Project Each group to create a POC (Proof of Concept) for their start-up applying their learnings from the CSBS course (core subjects + BCVS). The evaluation for this POC will be done as part of the Sem end assessment by the TCS team. During the assessment, students need to share the journey of creating their start-up: from inception to POC.		10 hours

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Semester 6

ROBOTICS + Lab (Elective III)

Work In Progress

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Semester 6

MODERN WEB APPLICATIONS + Lab (Elective III)

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Semester 6

DATA MINING AND ANALYTICS + LAB (ELECTIVE III)

Course Outcome(s):

Students will be able to

1. Understand basic concepts and techniques of Data Mining
2. Develop skills of using data mining software for solving practical problems
3. Understand and apply several statistical analysis techniques: regression, ANOVA, data reduction

Topics to Be Covered:

UNIT – I

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

UNIT – II

Data preprocessing: Data cleaning, Data transformation, Data reduction, Discretization and generating concept hierarchies, Installing Weka 3 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

UNIT – III

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

UNIT – IV

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Semester 6

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

Forecasting models: Heuristic methods, predictive modeling 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 semiparametric regression models, additive regression models. Introduction to nonparametric regression methods

UNIT – V

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 modeling-Multi-objective optimization-Stochastic modeling, Decision and Risk analysis, Decision trees.

Home Assignments:

1. **Experiments with Weka** – Visualization Techniques, using filters and statistics, mining association rules, decision trees rules, Prediction
2. **Mining real data:** Preprocessing data from a real domain (Medical/ Retail/ Banking); Applying various data mining techniques to create a comprehensive and accurate model of the data
3. **Analytics Assignment 1:** Conduct and Present a summary report on an End to end statistical model building exercise using sample data – Data preprocessing, Descriptive Analysis (Exploratory Data Analysis), Hypothesis building, Model Fitting, Model Validation and Interpretation of results
4. **Analytics Assignment 2:** Build statistical models using any two linear and non-linear regression techniques: Simple Linear Regression; Multiple Regression; Variable Selection Problem; Multicollinearity and Ridge Regression; Nonlinear regression; Non-parametric regression; Logistic regression (binary and multiple); Poisson/Negative binomial regression (Use sample data sets)

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Semester 6

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.

Hosmer, D. W. and Lemeshow, S. (1989). Applied Logistic Regression (Wiley).

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Semester 6

Enterprise Systems (Elective IV)

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Semester 6

Advance Finance (Elective IV)

Course Pre Requisite(s):

Good knowledge of Fundamentals of Management (Covered in Year 2, Semester 1)

Course Outcome(s):

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

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

Topics to Be Covered:

UNIT – I

Sources of Funds (including regulatory framework)
- Types of securities
- Issuing the capital in market
- Pricing of issue
- Valuation of Stocks and bonds

UNIT – II

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

UNIT – III

Evaluation of Lease Contracts

UNIT – IV

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

UNIT – V

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

UNIT – VI

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
  - Inventory Management

UNIT – VII

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

Text Books:

1. Brealey, Myers and Allen, *Principles of Corporate Finance*

Case Study Materials: To be distributed for class discussion

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Semester 6

Image Processing and Pattern Recognition (Elective IV)

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

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.

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Semester 7

TCS

Computer Science & Business Systems

Semester 7 Curriculum

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Semester 7

Usability Design of Software Applications + Lab

Course Pre Requisite(s):

Basic understanding of web and mobile app development

Course Outcome(s):

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.

To sensitise the students to the fundamentals of User Centred Design and User Experience their relevance and contribution to businesses
Familiarise them to the facets of User Experience (UX) Design, particularly as applied to the digital artefacts
Appreciation of user research, solution conceptualisation and validation as interwoven activities in the design and development lifecycle
Acquire the ability to constructively engage with the Design professionals they would work with in the future

Topics to Be Covered:

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 techiques will be imparted w.r.t. the group project selected by the students.
UX Research Understanding users, their goals, context of use, 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
Final presentation of solution – Exam

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Semester 7

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

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Semester 7

IT Workshop Skylab / Matlab (PCC-CS 302) + Lab

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

Working with variables, workspace and miscellaneous commands
Creating MATLAB 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

Text Books:

1. *Digital Image Processing using MATLAB*. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Pearson Education, Inc., 2004.
2. *MATLAB: A Practical Introduction to Programming and Problem Solving*. Stormy Attaway, Butterworth-Heinemann.

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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

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Semester 7

FINANCIAL MANAGEMENT

Course Outcome(s):

Students will be able to

- Understand the fundamental concepts of financial management
- Appreciate basic concepts such as time value of money, cost of capital, risk and return, working capital management, capital budgeting etc.
- Leverage the concept for deciding financial angle of IT projects

Topics to Be Covered:

UNIT - I

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

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

UNIT - II

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

4**. 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)

UNIT - III

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

6. **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

7. 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

UNIT – IV

8. **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.

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

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

Text Book

Chandra, Prasanna - Financial Management - Theory & Practice, Tata McGraw Hill.

References Books :

Srivastava, Misra: Financial Management, OUP

Van Horne and Wachowicz : Fundamentals of Financial Management, Prentice Hall/ Pearson Education.

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Semester 7

Human Resource Management

Course Outcome(s):

Students must be aware of the basic principles of Human Resource Management because success in today's complex business environment depends on effective management of its human resources. 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.

Topics to Be Covered:

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

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Semester 7

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

Home Assignment:

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. Few topics are mentioned below as examples. Instructor can add or change any topic as per requirement.

1. Topic: Understanding the issues and challenges involved in managing a diverse workforce
2. Topic: Is The Only Purpose of a Corporation to Maximize Profit?
3. Topic: Similarities and Differences in Manufacturing and Service Sector - Impact on HR Practices

Text Books:

Gary Dessler, *Human Resource Management*

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Semester 7

Cognitive Science & Analytics (Elective V)

SECTION – I: THEORY

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

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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 for qualitative as well as quantitative data;

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

UNIT 4: MULTIVARIATE DATA ANALYTICS & COGNITIVE ANALYTICS

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.

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

d. 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

a. Reactive Machine: Low memory, works on Known rules, such as Object Detection/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 Selected Commonly 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 Shot MultiBox 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

SECTION – II: LAB EXERCISES

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

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SECTION – III: TEXT BOOKS

Text Books

Unit 1

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

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

2. *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.

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SECTION – IV: PEDAGOGY

Unit 1

    1. Instructor Led
    2. Mini Assignments & Quiz.

Unit 2

    1. Instructor Led
    2. Mini Assignments & Quiz.

Unit 3

    1. Instructor Led
    2. Mini Assignments & Quiz.

Unit 4

    1. Instructor Led
    2. Mini Assignments & Quiz
    3. Industry Speakers

Unit 5

    1. Instructor Led
    2. Mini Assignments & Quiz
    3. Industry Speakers

Unit 6

    1. Industry Speakers

2. Mini Assignments & Quiz

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Semester 7

Introduction to IoT + Lab (Elective V)

Course Outcome(s):

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.

Topics to Be Covered:

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, WebSockets, protocols. Message encoding (JSON, Protocol Buffers)

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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

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/

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Semester 7

Cryptology (Elective V)

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

Bas ic 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.

Text Books:

3. *Cryptography, Theory and Practice.* D. R. Stinson, CRC Press.
4. *Handbook of Applied Cryptography.* A. J. Menezes, P. C. van Oorschot, and S. A. Vanstone, CRC Press

Reference Books:

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

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Note: If any student also opts for Quantum Computation & Quantum Information course, in that case the ciphers discussed in this course must differ from the ciphers that will be discussed in Quantum Computation & Quantum Information course.

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Semester 7

Quantum Computation & Quantum Information (Elective VI)

Introduction to Quantum Information: States, Operators, Measurements, Quantum Entanglement: Quantum Teleportation, Super-dense coding, CHSH Game, Quantum gates and circuits

Quantum Algorithms: Deutsch-Jozsa, Simon, Grover, Shor, Implication of Grover's and Simon's algorithms towards classical symmetric key cryptosystems, Implication of Shor's algorithm towards factorization and Discrete Logarithm based classical public key cryptosystems

Quantum True Random Number Generators (QTRNG): Detailed design and issues of quantumness, Commercial products and applications

Quantum key distribution (QKD): BB84, Ekert, Semi-Quantum QKD protocols and their variations, Issues of Device Independence, Commercial products

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

Text Books:

1. *Quantum Computation and Quantum Information.* M. A. Nielsen and I. L. Chuang, Cambridge University Press
2. Presskil Lecture notes: Available online: http://www.theory.caltech.edu/~preskill/ph229/

Reference Books:

1. *An Introduction to Quantum Computing.* P. Kaye, R. Laflamme, and M. Mosca, Oxford University Press, New York
2. *Quantum Computer Science.* N. David Mermin:, Cambridge University Press
3. *Quantum Cryptography.* D. Unruh:, Available online: https://courses.cs.ut.ee/all/MTAT.07.024/2017_fall/uploads/
4. *NIST Post Quantum Cryptography*, Available online: https://csrc.nist.gov/projects/post-quantum-cryptography/round-2-submissions
5. *Quantum Algorithms for Cryptographically Significant Boolean Functions - An IBMQ Experience*. SAPV Tharrmashastha, D. Bera, A. Maitra and S. Maitra, Springer 2020.
6. *Quantum Algorithm Zoo.* https://quantumalgorithmzoo.org/
7. *Handbook of Applied Cryptography.* A. J. Menezes, P. C. van Oorschot, and S. A. Vanstone. CRC Press

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Note: If any student also opts for Cryptology course, in that case the ciphers discussed in this course must differ from the ciphers that will be discussed in Cryptology course.

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Semester 7

Advanced Social, Text and Media Analytics (Elective VI)

Course Outcome(s):

Students will be able to

- To be able to use various tools for Text Mining and carry out Pattern Discovery, Predictive Modeling
- Explore the use of social network analysis to understand the growing connectivity and complexity in the world around us on different scales – ranging from small groups to the World Wide Web
- Perform social network analysis to identify important social actors, subgroups (i.e., clusters), and network properties in social media sites such as Twitter, Facebook, and YouTube

Topics to Be Covered:

UNIT – I

Text Mining: Introduction, Core text mining operations, Preprocessing 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 Modeling; Sentiment Analysis; Sentiment Prediction

UNIT – II

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

UNIT – III

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

Home Assignments:

1. **Language Analysis:** Students are expected to analyze the language of a category of text (e.g., literary, academic, social media) of their selection. Based on the analysis, students are expected to provide a critical description of the texts involved and possibly distinguishing them from other texts and/or uncovering relationships or concepts communicated by the text authors.

2. Students are required Perform sentiment analysis using Twitter. Students will be required to use off the-shelf software and/or code of their own to detect sentiment/emotion in the data and write a description of the methods they use and the results.

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

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Semester 7

Mobile Computing (Elective VI)

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.

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Semester 7

Laboratory

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

Text Books:

1. Mobile Communications. Jochen Schiller, Pearson Education.
2. *Wireless Communications.* Andrea Goldsmith, Cambridge University Press.

Reference Books:

3. *Wireless Communications: Principles and Practice.* Theodore Rappaport, Pearson Education.
4. *Wireless Communications.* Ezio Biglieri, MIMO, Cambridge University Press.
5. *Handbook of Wireless Networking and Mobile Computing.* Ivan Stojmenovic, Wiley.
6. *Dynamic Location Management in Heterogeneous Cellular Networks.* James Cowling,
7. MIT Thesis. http://people.csail.mit.edu/cowling/hons/jcowling-dynamic-Nov04.pdf
8. *Location Management in Wireless Cellular Networks.* Travis Keshav, https://www.cse.wustl.edu/~jain/cse574-06/ftp/cellular_location.pdf
9. *Location Management in Wireless Data Networks.* Fahd A. Batayneh, https://www.cse. wustl.edu/~jain/cse574-06/ftp/wireless_location.pdf
10. *Principles of Mobile Communication.* Gordon L. Stber, Springer.
11. *Wireless Device-to- DeviceCommunications and Networks.* Lingyang Song, Dusit Niyato, Zhu Han, and Ekram Hossain, Cambridge University Press.
12. *Principles of Cognitive Radio.* Ezio Biglieri, Andrea J. Goldsmith, Larry J. Greenstein, Narayan Mandayam and H. Vincent Poor, Cambridge University Press.
13. *Wireless Sensor Networks: Architecturesand Protocols.* Edgar H. Callaway, Jr. and Edgar H. Callaway, CRC Press.

A Discrete-Event Network Simulator. https://www.nsnam.org/docs/manual/html/index.html

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Semester 8

TCS

Computer Science & Business Systems

Semester 8 Curriculum

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Semester 8

Services Science & Service Ops Management

Course Pre Requisite(s):

Fundamentals of Management, Operations Research

Course Outcome(s):

Students will be able to

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

Topics to Be Covered:

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.

Text Books:

1. Fitzsimmons & Fitzsimmons, Service Management: Operations, Strategy, Information Technology, McGraw Hill publications (7th 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.

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Reference Papers:

1. Karmarkar, U. (2004). Will you survive the services revolution? Harvard Business Review, 100-107.
2. Vargo, S. L., & Lusch, R. F. (2008). From goods to service (s): Divergences and convergences of logics. Industrial marketing management, 37(3), 254-259.
3. Vargo, S. L., & Lusch, R. F. (2008). "Service-Dominant Logic: Continuing the Evolution," Journal of the Academy of Marketing Science (36:1), pp. 1-10
4. Silvestro, R., Fitzgerald, L., Johnston, R., & Voss, C. (1992). Towards a classification of service processes. International journal of service industry management, 3(3), 62-75.
5. Vargo, S. L., Maglio, P. P., & Akaka, M. A. (2008). On value and value co-creation: A service systems and service logic perspective. European management journal, 26(3), 145-152.
6. Shostack, G.L., (1984), "Designing Services That Deliver," Harvard Business Review, January-February 1984, pp. 132-139
7. Evenson, S., & Dubberly, H. (2010). Designing for service: Creating an experience advantage. Introduction to service engineering, 403-413.
8. Edvardsson, B., & Olsson, J. (1996). Key concepts for new service development. Service Industries Journal, 16(2), 140-164.
9. Goldstein, S. M., Johnston, R., Duffy, J., & Rao, J. (2002). The service concept: the missing link in service design research? Journal of Operations management, 20(2), 121-134.
10. Kumar, A., Zope, N. R., & Lokku, D. S. (2014, April). An approach for services design by understanding value requirements, identifying value carriers, developing value proposition, and subsequently realizing value. In Global Conference (SRII), 2014 Annual SRII (pp. 298-304). IEEE.
11. Parasuraman, A., Zeithaml, V.A., and Berry, L.L., (1985), "A Conceptual Model of Service Quality and Its Implications for Future Research," The Journal of marketing, Vol. 49, No. 4, pp. 41-50
12. Cronin, J.J., and Taylor, S.A., (1992), "Measuring Service Quality: A Reexamination and Extension," The Journal of Marketing, Vol. 56, No. 3, pp. 55-68
13. Van Ree, H. J., (2009), Service Quality Indicators for Business Support Services, Ph.D. Thesis, University College London, London.
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17. Barras, R. (1986). "Towards a Theory of Innovation in Services," Research Policy (15), pp. 161-173.

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19. Barrett, M., Davidson, E., Prabhu, J., & Vargo, S. L. (2015). "Service innovation in the digital age: key contributions and future directions". Mis Quarterly, 39(1), 135-154.
20. Lusch, R. F., and Nambisan, S. (2015). "Service Innovation; A Service-Dominant Logic Perspective," MIS Quarterly (39:1), pp.155-175

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Semester 8

IT Project Management (includes Agile / DevOps)

Course Outcome(s):

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.

Topics to Be Covered:

UNIT – I

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

UNIT – II

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.

UNIT – III

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

UNIT – IV

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

UNIT – V

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

UNIT – VI

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

UNIT – VII

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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.

UNIT – VIII

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

Workshop:

Workshops will be conducted as a part of this course which is mandatory for students to attend. The primary objective of the workshops is to teach the students the agile project management including Scrum and DevOps through group activities.

Home Assignment:

Case studies will be distributed to students beforehand and students should prepare and try to solve these cases before coming to class. Students will be asked submit and present their understanding of the cases and solutions before the class.

Text Books:

1. Mike Cohn, *Succeeding with Agile: Software Development Using Scrum*
2. Notes to be distributed by the course instructor on various topics

Reference Books:

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

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Semester 8

Advance Finance (Elective IV)

Course Outcome(s):

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

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

Topics to Be Covered:

UNIT – I

Sources of Funds (including regulatory framework)
- Types of securities
- Issuing the capital in market
- Pricing of issue
- Valuation of Stocks and bonds

UNIT – II

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

UNIT – III

Evaluation of Lease Contracts

UNIT – IV

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

UNIT – V

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

UNIT – VI

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

UNIT – VII

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.

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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

Text Books:

1. Brealey, Myers and Allen, *Principles of Corporate Finance*

Case Study Materials: To be distributed for class discussion

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Semester 8

Marketing Research & Marketing Management

Course Outcome(s):

Students will be able to

- Understand basic marketing concepts
- Comprehend the dynamics of marketing and analyze how its various components interact with each other in the real world
- Leverage marketing concepts for effective decision making
- Understand basic concepts and application of statistical tools in Marketing research

Topics to Be Covered:

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

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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) e.g. "Marketing Myopia"
2. Field visit & live project covering steps involved in formulating Market Research Project
3. Measuring Internet Marketing Effectiveness: Metrics and Website Analytics

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:

5. Marketing Management – Rajan Saxena
6. Marketing Management – S.A. Sherlekar

7. Service Marketing – S.M. Zha
8. Journals – The IUP Journal of Marketing Management, Harvard Business Review
9. Research for Marketing Decisions by Paul Green, Donald, Tull
10. Business Statistics, A First Course, David M Levine at al, Pearson Publication

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Semester 8

Behavioral Economics + Lab

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Lectures: 4 Hrs/Week	Semester Examination: 60 marks	4
Tutorials: Nil	Continuous Assessment: 40 marks	
Lab: Nil	Term Work: Nil	

Behavioral Economics (Elective – II)

Course Objective: 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

Course Outcome: Students will be able to understand and apply various concepts in traditional and modern Microeconomics, focusing on decision making, and develop a holistic understanding of these concepts and their interconnections

Unit I

I. 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.

Unit II

II. 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

Unit III

III. 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

Unit IV

IV. 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.

Unit V

V. 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

Unit VI

VI. Strategic choice

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1. 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

2. 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

Text Book: An Introduction to Behavioral Economics, by N. Wilkinson and M. Klaes

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Computational Finance & Modeling (Elective – II)

Course Objective:

Post successful completion of this course, students will be able to:

1. Understand existing financial models in a quantitative and mathematical way.
2. Apply these quantitative tools to solve complex problems in the areas of portfolio management, risk management and financial engineering.
3. Explain the approaches required to calculate the price of options.
4. Identify the methods required to analyse information from financial data and trading systems.

Topics to Be Covered:

UNIT – I

Numerical methods relevant to integration, differentiation and solving the partial differential equations of mathematical finance: examples of exact solutions including Black Scholes and its relatives, finite difference methods including algorithms and question of stability and convergence, treatment of near and far boundary conditions, the connection with binomial models, interest rate models, early exercise, and the corresponding free boundary problems, and a brief introduction to numerical methods for solving multi-factor models.

UNIT – II

Black-Scholes framework: Black-Scholes PDE: simple European calls and puts; put-call parity. The PDE for pricing commodity and currency options. Discontinuous payoffs - Binary and Digital options. The Greeks: theta, delta, gamma, vega & rho and their role in hedging. The mathematics of early exercise - American options: perpetual calls and puts; optimal exercise strategy and the smooth pasting condition. Volatility considerations - actual, historical, and implied volatility; local vol and volatility surfaces.

Simulation including random variable generation, variance reduction methods and statistical analysis of simulation output. Pseudo random numbers, Linear congruential generator, Mersenne twister RNG. The use of Monte Carlo simulation in solving applied problems on derivative pricing discussed in the current

finance literature. The technical topics addressed include importance sampling, Monte Carlo integration, Simulation of Random walk and approximations to diffusion processes, martingale control variables, stratification, and the estimation of the "Greeks. "

UNIT – III

Financial Products and Markets: Introduction to the financial markets and the products which are traded in them: Equities, indices, foreign exchange, and commodities. Options contracts and strategies for speculation and hedging.

UNIT – IV

Application areas include the pricing of American options, pricing interest rate dependent claims, and credit risk. The use of importance sampling for Monte Carlo simulation of VaR for portfolios of options.

UNIT – V

Statistical Analysis of Financial Returns: Fat-tailed and skewed distributions, outliers, stylized facts of volatility, implied volatility surface, and volatility estimation using high frequency data.

UNIT – VI

Copulas, Hedging in incomplete markets, American Options, Exotic options, Electronic trading, Jump Diffusion Processes, High-dimensional covariance matrices, Extreme value theory, Statistical Arbitrage.

References:

1. R. Seydel: Tools for Computational Finance, 2nd edition, Springer-Verlag, New York, 2004.
2. P. Glasserman: Monte Carlo Methods in Financial Engineering, Springer-Verlag, New York, 2004.
3. W. Press, S. Teukolsky, W. Vetterling and B. Flannery, Numerical Recipes in C: The Art of Scientific Computing, 1997. Cambridge University Press, Cambridge, UK. Available on-line at: http://www.nr.com/
4. A. Lewis: Option Valuation under Stochastic Volatility, Finance Press, Newport Beach, California, 2000.
5. A. Pelsser: Efficient Methods for Valuing Interest Rate Derivatives, Springer-Verlag, New York, 2000.

6. D. Ruppert, Statistics and Data Analysis for Financial Engineering
7. R. Carmona: Statistical Analysis of Financial Data in S-Plus
8. N. H. Chan, Time Series: Applications to Finance
9. R. S. Tsay, Analysis of Financial Time Series
10. J. Franke, W. K. Härdle and C. M. Hafner, Statistics of Financial Markets: An Introduction

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Semester 8

INDUSTRIAL PSYCHOLOGY

Course Objective:

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.

Course Outcome(s):

Students will be able to

- Become conversant about the major content areas of Industrial Psychology (i.e., job analysis, recruitment, selection, employment law, training, performance management, and health/well-being issues in the workplace).
- Gain further comfort with statistical concepts in the context of making personnel decisions to reinforce content learned in PSY203 or an equivalent introductory statistics course.
- Gain practical experience by completing a series of hands-on projects involving job analysis, selection decisions, training programs, and employee well-being.
- Deepen your understanding of tests and measurements so that you can collect accurate information and make sound data-based decisions.
- Prepare for other focused seminar courses in Industrial/Organizational Psychology or Human Resource Management.

Topics to Be Covered:

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

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Semester 8

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

Text Book:

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

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Semester 8

Enterprise Systems + Lab

Attached Separately

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Semester 8

Image Processing and Pattern Recognition + Lab

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

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.