CHRIST
(DEEMED TO BE UNIVERSITY)
LAVASA, PUNE, INDIA

Department of Computer Science

Pune Lavasa Campus

Syllabus

BSc
(Data Science)

2020-21

CHRIST (Deemed to be University)
Pune Lavasa Campus
www.lavasa.christuniversity.in

PROGRAMME STRUTURE

I Semester

SUBJECT CODE	SUBJECT NAME	Hrs/ Week	Credit	Max Marks
BDS121	Professional English	3	3	100
BDS122	Language – II	3	3	100
BDS131	Discrete Mathematics	4	4	100
BDS132	Statistical Methods	4	4	100
BDS133	Digital Computer Fundamentals	4	4	100
BDS171	Programming in Python (CIA Only)	7	5	150
HOL111	Holistic Education	1		
EVS123	Environmental Studies	2	2	
		28	**25**	**650**

II SEMESTER

SUBJECT CODE	SUBJECT NAME	Hrs/ Week	Credit	Max Marks
BDS221	Communicative English	3	3	100
BDS222	Language – II	3	3	100
BDS231	Calculus of Several Variables	4	4	100
BDS232	Probability and Distribution	4	4	100
BDS233	Principles of Data Science	4	4	100
BDS271	Data Structures Using C (CIA Only)	6	5	150
BDS272	R Programming (CIA Only)	4	4	100
HOL211	Holistic Education	1	2	
		29	**29**	**750**

III SEMESTER

SUBJECT CODE	SUBJECT NAME	Hrs/ Week	Credit	Max Marks
BDS331	Graph Theory	4	4	100
BDS332	Statistical Inferences	3	3	100
BDS333	Database Management System	4	4	100
BDS334	Professional Ethics in Computing	2	2	50
BDS351	Graph Theory Lab using Python (CIA Only)	2	2	50
BDS352	Statistical Inferences (CIA Only)	2	2	50
BDS371	Applied Excel (CIA Only)	4	3	100
BDS372	Programming in JAVA (CIA Only)	8	6	200
HOL311	Holistic Education	1		
		30	**26**	**750**

IV SEMESTER

SUBJECT CODE	SUBJECT NAME	Hrs/ Week	Credit	Max Marks
BDS431	Linear Algebra	4	4	100
BDS432	Sampling Techniques	3	3	100
BDS433	Operating System	4	4	100
BDS434	Software Engineering	3	3	100
BDS451	Linear Algebra Lab (CIA Only)	2	2	50
BDS452	Sampling Techniques Lab (CIA Only)	2	2	50
BDS471	Data Mining (CIA Only)	6	5	150
BDS481	DBMS Project (CIA Only)	5	3	100
HOL411	Holistic Education	1	2	
		30	**28**	**750**

V SEMESTER

SUBJECT CODE	SUBJECT NAME	Hrs/ Week	Credit	Max Marks
BDS531	Regression Modelling	4	4	100
BDS532	Operation Research	4	4	100
BDS533	Data Communication and Networking	4	4	100
BDS551	Regression Modelling (CIA Only)	2	2	50
BDS571	Machine Learning (CIA Only)	6	5	150
BDS572	Elective – I	4	4	100
BDS573	Elective – II (CIA Only)	6	5	150
BDS591	Introduction to Econometrics	2	2	50
		32	**30**	**800**

VI SEMESTER

SUBJECT CODE	SUBJECT NAME	Hrs/ Week	Credit	Max Marks
BDS631	Time Series Modelling	4	4	100
BDS671	Big data Analytics (CIA Only)	6	5	150
BDS672	Elective – III (CIA Only)	6	5	100
BDS691	Human Resource Management	4	4	100
BDS692	Introduction to Bioinformatics	2	2	50
BDS681	Project (CIA Only)	10	5	300
		32	**25**	**800**

FIRST SEMESTER

BDS121 - PROFESSIONAL ENGLISH

Total Teaching Hours for Semester: 45
Max Marks: 100 **Credits: 3**

Course Objectives: This course focuses on preparing students to communicate verbally and non-verbally in an effective manner. The aim is to introduce students to communication in a professional environment. The application based modules sensitize students to the function of English language in their careers. It is instrumental in learners comprehending the role of technical English in communication.

1. Introduce learners to language skills in their area of specialization.
2. Enable them to enhance career prospects and employability through English language skills
3. Help students gain understanding of language at the workplace
4. To develop verbal and non-verbal skills in English communication

Course Outcomes:

1. Comprehension and demonstration of language in the field of technology
2. Prepare individuals as Independent communicators
3. Illustrate professional requirements through language proficiency

UNIT 1: FOUNDATION OF LANGUAGE **8 Hrs.**

This unit undertakes to revise the foundation of language; the grammar section of language learning. Students will be reviewed the grammar aspects mentioned through task based activities

1. Concept of time in language – reflective learning will be used to help students detect their grammatical errors in tenses and rectify.
2. Degrees of comparison – using technical literature students can be engaged in apprehending degrees of comparison
3. Direct and reported speech – to enable learners carry on a comprehensible conversation either spoken or written, in a business context
4. Subject verb agreement – through worksheets and task based learning students will be familiarized to construct error free sentences

UNIT 2: BASICS OF ENGLISH LANGUAGE LEARNING **6 Hrs.**

Learners will be acquainted with the basic of English language learning. They will be taught to identifying technical vocabulary from the general. Technical magazines prescribed by the institution that are subject specific can be used as teaching tools.

1. Introduction to technical lexicon – help students identify jargon and technical terminologies. Assist them comprehend the significance of implementation with moderation through their subject literature.
2. Internet lexis and contextualization – provide meanings accurately to ensure right exercise of terms in a professional scenario through hands-on experience
3. Circumstantial usage of diction – aid the comprehension of word usage as verbs and nouns based on the requirement. Differentiating the meanings of synonyms and their orientation in a text
4. Integrating technical vocabulary in describing process and procedure – through prescribed texts

students can be made to enhance their language by right integration of diction.Mind mapping of textual diction and allied words – diagrammatically mapping of words based on their meaning, context and usage will re-emphasise the words in the minds of the learners.

UNIT 3: TYPES OF READING **8 Hrs.**

Having gained familiarity with technical and subject specific vocabulary, students will be introduced to the types of reading. The basic receptive skill will help students help students prioritise and eliminate content.

1. Reading strategies – acquaint the learners with the functions and benefits of reading strategy in the academic and professional set-up
2. Reading: skimming, scanning – introduce learners to the types of reading. The integral aspects of each method will be familiarized to the students. They can be given practice sessions through subject material provided
3. Intensive and extensive reading – benefits and features of the two types of reading can be elaborated. To emphasize on the learner the difference, practice sessions with subject material can be carried out
4. Summarizing – consolidation of key ideas can be carried out in the spoken and written format. Technical literature can be provided for the purpose.

UNIT 4: NON-VERBAL COMMUNICATION **5 Hrs.**

The ancillaries of speaking skill are in focus here. Prior to delving into the productive skill, the nitty gritty that enhance its effectiveness is made familiar to the learner. Classroom activities and vicarious learning through case studies and video clippings can be screened.

1. Competence in non-verbal communication- create an awareness of the role of non-verbal communication in a professional set-up
2. Functions of non-verbal communication – the various utilities of nonverbal communication can be elaborated to students with case studies
3. Benefits of non-verbal communication – elucidate the advantages of non-verbal communication with reference to cultural distinctions
4. Proxemics, Chronemics, Kinesics, Haptics, Gestures, Paralanguage - vicarious learning of these aspects of non-verbal communication can be carried out through video clippings of suitable material and print media

UNIT 5: COMMUNICATION STRATEGIES **4 Hrs.**

The productive skills are finessed through identification and refining of the elements mentioned in this unit. They contribute to holistic presentation. Task based activities must be used to practice. Business Communication texts and worksheets will provide ample support.

Nuances of Communication – communication in the work place requires knowing the dos and don’ts of professional communication. An introduction to listening, speaking, reading and writing with reference to professional communication can be provided.

1. Opening techniques
2. Speech markers
3. Fillers
4. Turn taking
5. Back channeling
6. Dealing with interruptions every element mentioned can be elaborated.

Ample examples can be provided through audiovisual media, it can be provided to them through demonstrations and verbal reinforcement language check lists can be provided to aid students understand implementation of the elements. A follow up through mock sessions must be carried out in groups

UNIT 6: WRITING **6 Hrs.**

Having dealt with speaking skill in the previous unit, the other productive skill; writing is taken into consideration here. The various forms of writing in an official context will be taught in form and content.

1. Report writing – a corporate requirement is the ability to report on meetings and conferences. The format and requirements of a report writing can be taught to the students through samples and later they can be made to draft reports of their own and peer evaluated
2. Note taking – corporate atmosphere calls for not taking at every step. Students need to be taught the framework of note taking. They can be given samples as reference. Later they can be made to listen to technical audio clips and provide the note taking carried out at an individual level.
3. Minutes – corporate life calls for being in attendance of numerous meetings. Taking down the minutes is a skill that is assumed to be possessed by one. The essentials of maintaining the minutes must be made conversant through illustrations. This can be emphasised by classroom activities of the same

UNIT 7: SMALL TALK **8 Hrs.**

Lastly students will be introduced to typical work scenarios through hands-on sessions.

1. Small talk – the purpose and role of small talk must be taught to the students. They can be screened video clippings of the same. Mock sessions can be performed in the class. The key phrases and language used can be imparted through provision of language worksheets and skills checklists
2. Meeting- types of meetings, hierarchy of most often featuring members, etiquette to be held at meeting and the duties to be performed can be taught implicitly. Chairing, setting the agenda, controlling the smooth functioning, participating, deliberating and diplomacy must be made clear. The key phrases and language used can be taught through language worksheets and skills checklists
3. Group discussion – group discussions are carried out at every level. Students must be familiarized with the basics of a group discussion. Agreeing, disagreeing, and being diplomatic are essentials to be imparted. The soft skills and language essentials most commonly noted can be made comprehensible to the students. Vicarious learning and language charts can be used as learning tools.

ESSENTIAL READING / RECOMMENDED READING

1. *Driscoll, Liz. Common Mistakes at Intermediate and How to Avoid Them. CUP, 2008.*
2. *Carter, Ronald and Michael McCarthy. Cambridge Grammar of English. CUP, 2006.*
3. *Leech, Geoffrey, Jan Svartvik. A Communicative Grammar of English. Third Edition. New Delhi: Pearson Education, 2009.*
4. *Booher, Dianna. E- Writing: 21st Century Tools for Effective Communication. Macmillan, 2008.*
5. *Knapp .M. Essentials of Non-Verbal Communication Theory Rea. FL: Harcourt, 1995.*

BDS131 - DISCRETE MATHEMATICS

Total Teaching Hours for Semester: 60
Max Marks: 100 **Credits: 4**

COURSE OBJECTIVES/COURSE DESCRIPTION: This course aims at introducing the students into the world of Discrete Mathematics. It includes the topic like Mathematical Logic, Set Theory, Functions, Matrices, Relations and Boolean algebra. They gain problem-solving skills in modern discrete mathematics and application of the same in the field of Computer Science.

COURSE OUTCOMES:

1. Formulate and interpret statements by applying the rules and methods of propositional logic
2. Demonstrate a working knowledge of set notation and elementary set theory, recognize the connection between set operations and logic
3. Prove elementary results involving sets
4. Apply the different properties of injections, surjections, bijections, compositions, and inverse functions
5. Demonstrate the use of mathematical reasoning by justifying and generalizing patterns and relations
6. Determine when a relation is reflexive, symmetric, antisymmetric, or transitive, apply the properties of equivalence relations and partial orderings, and explain the connection between equivalence relations
7. Gain enhanced understanding on Boolean algebra and it uses in Circuits

UNIT 1: FOUNDATIONS OF MATHEMATICAL LOGIC 15 Hrs.

Propositional Logic: Propositions, Conditional Statements, Truth tables of Compound Statements, Precedence of Logical Operators, Logic and bit operations – Applications of Propositional Logic: Translating English sentences, System specifications, Boolean Searches, Logic Puzzles, Logic Circuits Propositional Equivalences: Compound proposition, Logical Equivalences, Using De Morgan's Laws, Constructing new logical equivalences, Propositional Satisfiability, Applications of Satisfiability: A Sudoku Puzzle, Predicates and Quantifier: Predicates, Quantifiers, Quantifiers with Restricted Domains, Precedence of Quantifiers.

UNIT 2: PERMUTATIONS, COMBINATIONS AND FUNCTIONS 15 Hrs.

Permutations: permutation, r-permutations, circular r-permutations, permutations with repetitions, permutations with indistinguishable objects, Combinations: r-combinations, combinations with repetitions, Functions: Definition of a Function, functions in programming languages, One-to-One and Onto functions, One to one correspondence, Inverse functions and compositions of functions, Graphs of functions, Floor, ceiling, greatest Integer and Factorial functions,, partial functions.

UNIT 3: MATRICES AND RELATIONS 15 Hrs.

Matrices: Matrix, Matrix Arithmetic, Transposes and Powers of Matrices, Zero-One Matrices: Boolean Product, Diagonal Matrix, Inverse of Matrix, System of Linear equations and Matrices –
Relations: Relations and Products, Functions as Relations, Relations on a Set, Properties of Relations: reflexive, irreflexive, symmetric, asymmetric, antisymmetric, transitive, inverse and complementary relations, Combining Relations,

n-ary Relations and their applications: n-ary Relations, Databases and Relations, Operations on n-ary Relations, SQL.

UNIT 4: BOOLEAN ALGEBRA **15 Hrs.**

Boolean Functions: Boolean Expressions and Boolean Functions, Identities of Boolean Algebra, Duality, The Abstract definition of a boolean algebra, Representing Boolean Functions: Sum-of-Products expansions, Product-of-Sums expansions, Functional Completeness, Logic Gates: Combinations of Gates, Half Adder, Full Adder, Minimization of Circuits: Karnaugh Maps, Don't Care Conditions, The Quine-McCluskey Method.

ESSENTIAL READING

1. *K. H. Rosen, Discrete Mathematics and its Applications, 7th ed., McGraw – Hill, 2012.*

REFERENCE READING

1. *R.P. Grimaldi and B.V. Ramana, Discrete and Combinatorial Mathematics, An applied introduction, 5th ed., Pearson Education, 2007.*
2. *D. S. Chandrasekharaiah, Discrete Mathematical Structures, 4th ed., India: PRISM Book Pvt. Ltd., 2012.*
3. *J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Application to Computer Science, Reprint, India: Tata McGraw Hill Education, 2008.*

BDS132 - STATISTICAL METHODS

Total Teaching Hours/Semester: 60
Max Marks: 100 Credits: 4

COURSE DESCRIPTION: This course is designed to introduce the historical development of statistics, presentation of data, descriptive measures and fitting mathematical curves for the data. This course also introduces measurement of relationship of quantitative and qualitative data and the concept of probability.

COURSE OBJECTIVE: To enable the students understand and apply the descriptive measures and probability for data analysis.

COURSE OUTCOMES:

1. Demonstrate the history of statistics and present the data in various forms.
2. Infer the concept of correlation and regression for relating two or more related variables.
3. Demonstrate the probabilities for various events.

UNIT 1: ORGANIZATION AND PRESENTATION OF DATA 10 Hrs.

Origin and development of Statistics, Scope, limitation and misuse of statistics. Types of data: primary, secondary, quantitative and qualitative data. Types of Measurements: nominal, ordinal, discrete and continuous data. Presentation of data by tables: construction of frequency distributions for discrete and continuous data, graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods).

UNIT 2: DESCRIPTIVE STATISTICS 15 Hrs.

Measures of location or central tendency: Arthimetic mean, Median, Mode, Geometric mean, Harmonic mean. Partition values: Quartiles, Deciles and percentiles. Measures of dispersion: Mean deviation, Quartile deviation, Standard deviation, Coefficient of variation. Moments: measures of skewness, Kurtosis.

UNIT 3: CORRELATION AND REGRESSION 10 Hrs.

Correlation: Scatter plot, Karl Pearson coefficient of correlation, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only). Regression: Concept of errors, Principles of Least Square, Simple linear regression and its properties.

UNIT 4: ASSOCIATION OF ATTRIBUTES 10 Hrs.

Relation between class frequencies, consistency of data, independence of attributes, criterion of independence, association of attributes: Yule’s coefficient of association, Yule ‘coefficient of colligation.

UNIT 5: BASICS OF PROBABILITY 15 Hrs.

Random experiment, sample point and sample space, event, algebra of events. Definition of Probability: classical, empirical and axiomatic approaches to probability, properties of probability. Theorems on probability, conditional probability and independent events, Laws of total probability, Baye’s theorem and its applications.

ESSENTIAL READING

1. Rohatgi V.K and Saleh E, An Introduction to Probability and Statistics, 3rd edition, John Wiley & Sons Inc., New Jersey, 2015.
2. Gupta S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, 11th edition, Sultan Chand & Sons, New Delhi, 2014.

RECOMMENDED READING

1. Mukhopadhyay P, Mathematical Statistics, Books and Allied (P) Ltd, Kolkata, 2015.
2. Walpole R.E, Myers R.H, and Myers S.L, Probability and Statistics for Engineers and Scientists, Pearson, New Delhi, 2017.
3. Montgomery D.C and Runger G.C, Applied Statistics and Probability for Engineers, Wiley India, New Delhi, 2013.
4. Mood A.M, Graybill F.A and Boes D.C, Introduction to the Theory of Statistics, McGraw Hill, New Delhi, 2008.

BDS133 - DIGITAL COMPUTER FUNDAMENTALS

Total Teaching Hours for Semester: 60
Max Marks: 100 Credits: 4

COURSE OBJECTIVES AND DESCRIPTIONS: This is an introductory course that provides required knowledge about digital fundamentals of computer. The course covers few topics like number systems, logic gates and flips flops. The course starts with an introduction to number systems and its applications in computers. The discussion about working of devices like encoders and decoders, multiplexers and de multiplexers are dealt with.

COURSE OUTCOMES:

1. Ability to use math and Boolean algebra in performing computations in various number systems.
2. Demonstrate Simplification of Boolean algebraic expressions.
3. Able to design efficient combinational and sequential logic circuit implementations from functional description of digital systems.

UNIT 1: INTRODUCTION TO NUMBER SYSTEM AND CODES 12 Hrs.

Number systems: Decimal numbers,
Binary numbers: Counting in binary, The weighted structure of binary numbers, Octal numbers, hexadecimal numbers and their mutual conversions ,
Binary arithmetic: Addition, subtraction, multiplication and division of binary numbers, 1‘s and 2‘s complement, signed numbers,
Arithmetic operations: addition, subtraction with signed numbers, 9‘s and 10‘s complement, BCD numbers, BCD addition, BCD subtraction,
Gray code: Binary to Gray code conversion, Gray to Binary conversion, Weighted code : 8421 code and Non weighted codes : ASCII and EBCDIC.

UNIT 2: BOOLEAN ALGEBRA 8 Hrs.

Boolean operations and expressions, Laws and rules of boolean algebra, Demorgan‘s Theorem, Boolean expressions, Simplification of Boolean expression.

UNIT 3: LOGIC GATES 10 Hrs.

AND gate, OR gate, NOT gate , NAND gate , NOR gate , X-OR gate , X-NOR gate, The universal property of NAND gate and NOR gate, Realization of basic gates.Boolean expression for logic circuits, Karnaugh map SOP with examples.

Self-Learning:
Universal property of NOR gate

UNIT4: COMBINATIONAL LOGIC 10 Hrs.

Basic Adders : Half adder, Full adder, 4-bit Parallel adders, Subtractor : Half subtractor, Full subtractor Implementation using logic gates, Decoders: 4 bit decoder, BCD to decimal decoder, Encoder : Decimal to BCD encoder, Multiplexer : 4 to 1 multiplexer, Demultiplexer : 1 to 4 demultiplexer.

UNIT 5: FLIP-FLOPS 10 Hrs.

Latches : SR latch, Clocked flip-flops :SR flip-flop, D flip-flop, JK flip-flop, Positive edge triggered flip flops, Timing diagrams , Master slave JK flip-flop.

UNIT 6: REGISTERS AND COUNTERS **10 Hrs.**

Modes of operation of registers: SISO, SIPO, PISO, and PIPO, Asynchronous counters: Four bit ripple counter, Decade counter, Synchronous counters: Four bit synchronous counter, Decade counter.

Self-Learning:

Introduction to RAM,SRAM, DRAM, ROM, PROM, EPROM, EEPROM

ESSENTIAL READING

1. *Floyd, Thomas L: Digital Computer Fundamentals, 11th Edition, Pearson International, 2015.*

REFERENCE READING

1. *Malvino, Paul Albert , Leach, Donald P,GautamSaha: Digital Principles And Applications, TMH, 8th Edition, 2015.*
2. *Bartee, Thomas C: Digital Computer Fundamentals, 6 Edition,TMH, 2010*

BDS171 - PROGRAMMING IN PYTHON

Total Teaching Hours for Semester: 105
Max Marks: 150 **Credits: 5**

COURSE OBJECTIVES: The objective of this course is to provide comprehensive knowledge of paradigms of python programming language.

COURSE OUTCOMES:

1. Demonstrate the use of built-in objects of Python
2. Apply the programming concepts of Python for data science applications.
3. Implement GUI and Web based programming concepts.

UNIT 1: INTRODUCTION **7 Hrs.**

Introduction to Python, Underlying mechanism of Module Execution- Whitespace Formatting, Operators, Control Statements, Arithmetic Functions and String functions. Sequences, Mapping and Sets- Dictionaries- Functions - Lists and Mutability- Problem Solving Using Lists and File handling.

UNIT 2: OBJECT ORIENTED PROGRAMMING USING PYTHON AND REGULAR EXPRESSIONS **7 Hrs.**

Classes: Classes and Objects, Inheritance—Polymorphism- Abstract classes-Exceptional Handling, Types of exception-Inbuilt, User defined, Regular Expressions using "re" module.

UNIT 3: GUI PROGRAMMING **7 Hrs.**

Introduction-Tkiner module-Root window-Widgets-Button-Label-Message-Text-Menu-Listboxes-Spinbox-Creating tables

UNIT 4: INTRODUCTION TO WEB FRAMEWORK-DJANGO **8 Hrs.**

Introduction-Web framework-creating model to add database service-python application shell-Django administration application-input-forms and models

UNIT 5: USING NUMPY **8 Hrs.**

Introduction to Numpy, Computation on NumPy-Aggregations-Computation on Arrays-Comparisons, Masks and Boolean Arrays-Fancy Indexing-Sorting Arrays-Structured Data: NumPy's Structured Array.

UNIT 6: USING PANDAS AND MATPLOTLIB **8 Hrs.**

Introduction to Pandas, Data Series, Data Frames, Data Wrangling, Data indexing and Selection-Operating on Data in Pandas-Handling Missing Data-Hierarchical Indexing. Visualizing Data-Matplotlib, Bar Charts, Line Charts, Scatterplots, Linear Algebra, Vectors, Matrices.

LIST OF PROGRAMMES FOR PRACTICAL **60 Hrs.**

1. Implement the concepts of variables and operators.
2. Implement the concepts of Strings.
3. Demonstrate the concept of Sets using real world scenario.
4. Demonstrate the concept of Lists using real world scenario.
5. Demonstrate the concept of Tuples using real world scenario.
6. Demonstrate the concept of Dictionaries using real world scenario.
7. Demonstrate the concept of File operations.
8. Implement the concept of Inheritance.
9. Implement the concept of Exception handling using predefined and user defined exceptions.
10. Demonstrate usage of basic and advance Regular expressions.
11. Demonstrate the concept of building a GUI using Tkiner.
12. Demonstrate the concept of building a web framework using Django.
13. Implement the concepts of aggregation, Indexing and sorting using Numpy Arrays.
14. Implement the concept of data series and data frames using Pandas.
15. Demonstrate the concept of data visualization using Matplotlib.

ESSENTIAL READING

1. *Wesely J.Chun,Core Python Application Programming ,Prentice Hall,third edition 2015.*
2. *T.R.Padmanabhan, Programming with Python,Springer Publications,2016.*

SECOND SEMESTER

BDS221 - COMMUNICATIVE ENGLISH

Total Teaching Hours for Semester: 45
Max Marks: 100 **Credits: 3**

COURSE OBJECTIVES: This course focuses on making students understand the vitality of English as a tool in implementing and; interpreting technical and professional communication. The course aims at detecting and nurturing research skills through English for professional development. A holistic approach to recognize the fundamental role of language in technical communication is undertaken.
Nurture an enquiring spirit through English language in Technical communication
Enhance English implementation in English learning for professional purposes
Encourage students towards autonomous learning through enhanced English comprehension that go beyond the classroom

COURSE OUTCOMES:

1. Demonstrate better comprehension and interpretation of technical literature
2. Rudimentary research aptitude through language up-gradation will be initiated
3. Learn the nuances of professional communication through English language

UNIT 1: PRONUNCIATION **8 Hrs.**

The most regularly used words in their field of knowledge, the most often committed mistakes and their right pronunciation will be given to the students. Applications available in this context can be made familiar to learners.
Phonetics – students can me taught phonetics through phonetic apps that enable the student to relate the symbol with the sound. They can be taught to read and transcribe words to ensure ample understanding
Commonly mispronounced words – technical vocabulary can be focused here. Audio sessions can be implemented to enable auditory retention
Common errors in grammar – cooperative language learning will help students familiarize common errors and rectifications

UNIT 2: TECHNICAL LITERATURE **10 Hrs.**

Students need to learn to read and study literature of their subject. Any form of literature in context to the subject can be taken and students can be involved in these chapters mentioned below
Comprehensive questioning of procedural writings & Comprehension answering of procedural queries – through subject based literature students can be taught cognition and responding to the prescribed material through writing and speaking
Issuing of instructions – instructions being an integral part of their area of expertise, students need to be made familiar with the sequencing and of ideas and brevity of language. This can be carried out through written and spoken format.
Procedural instructions – a set of operating procedures for a piece of technical equipment can be carried out in through first through oral presentations and writing exercises
Discussion of processes, errors or glitches – going beyond the usual, students must be acquainted with dealing the nitty-gritty of technical literature. They must be taught to spell out glitches or errors to enable smooth functioning

UNIT 3: RESEARCH ORIENTATION **8 Hrs.**

An integral part of in-depth learning involves research. In this unit research will be introduced to the students. The nuances of exploratory study and their approaches will be made familiar to the students

Structure of the essay – students need to be familiarized on the format and elements that contribute to a holistic essay. Deconstruction of essays can be carried out through cooperative learning and deliberated.

Topic sentence recognition – Technical English calls for detection of topic sentence recognition of any technical literature. Students can be taught on detecting keywords and significant concepts that will aid in the process

Thesis statement identification – research publications are an integral part of technical writing. Students can be provided research articles and familiarized on the format and texture of a thesis statement

Interpretation of data – quantitative study is entirely dependent on data analysis and interpretation. The language to be used in the process can be fine-tuned for the students through case studies of the same

Comprehension, organization of ideas and execution of writing project proposal – once learners have been taught the elements of a research paper, they can be encouraged to work in groups and draft their own research paper integrating all the major elements.

UNIT 4: ANALYTICAL **6 Hrs.**

An extension of rudimentary research is present in this chapter. Students will be encouraged to analyse texts, interpret and rewrite them.

Rhetoric analysis; a comparative analysis of two texts – in context to the literature prescribed, students must be enabled to make a detailed study of the texts and chart out differences and similarities.

Critical analysis – students can be taught to scrutinise the text based on the context and produce a systematic response

Paraphrasing – in a professional atmosphere data needs to be interpreted and paraphrased. Tasks with data analysis can be used to help students comprehend the implementation of paraphrasing in the written

UNIT 5: OFFICIAL CORRESPONDENCE **6 Hrs.**

Productive skill; writing is nurtured in this chapter. A few elements of the same was handled in the first semester. Here students will further finesse their writing skills

Official letter – the types and format of official letter can be imparted through examples. Students can be then asked to draft letters of their own. Etiquettes of letter writing, register, style and specific language phrases must be taught. H examples can be used to emphasise.

Internet correspondence – the soft skills for corresponding through email, carbon copying, blind carbon copying, salutations, register, style, format and diction must be made familiar to the students,

Resume writing – the organization of a resume along with the covering letter can be imparted to the learners through providing several samples. They can then be made to draft a resume with covering letter of their own.

UNIT 6: SPEAKING SKILLS **7 Hrs.**

The previous semester dealt with a few productive oral skills. Furthering their productive expertise, speaking skills are taken into consideration. Students will be encouraged to demonstrate their skills under guidance of the teacher.

Interview – types of interviews can be elaborated to the learners. The essential language and skills required must be emphasised verbally and through case studies. Students can be encouraged to demonstrate the acquired knowledge through simulated sessions.

Presentations – the critical features and language checklists must be emphasised. Introducing the topic, linking, sequencing and dealing with questions must be mad familiar. The soft skills and paralinguistic aspects can be taught through examples. Group demonstrations must be mandatory

Conference – the soft skills and language finesse required must be made clear to the students. Checklists can be provided as learning aids. Chairing sessions, targeting issues, key language, and steering the meeting is required to be acquainted. Audio visual examples can be screened and re-emphasis through practice sessions can be carried out.

RECOMMENDED READING

1. Day, R A. Scientific English: A Guide for Scientists and Other Professionals. 2nd ed. Hyderabad: Universities Press, 2000.
2. Meenakshi Raman and Sangeetha Sharama . 2009. Technical Communication- Principles and Practice; - Oxford University Press,
3. Jay. Effective Presentation. New Delhi: Pearson, 2009.
4. English for Effective Communication. Oxford University Press, 2013.
5. Lynch, Tony. Study Listening. New Delhi. CUP, 2008.

BDS231 - CALCULUS OF SEVERAL VARIABLES

Total Teaching Hours for Semester: 60
Max Marks: 100 **Credits: 4**

COURSE OBJECTIVES/COURSE DESCRIPTION: This course aims at introducing the fundamentals required for learning about Differentiation, Vector and Vector functions, Partial Derivatives, Directional derivative, Gradient vectors and differentials. The course helps in gaining sufficient problem solving skills on multivariable calculus and its applications.

COURSE OUTCOMES:

1. Understand and use the notion of Derivative of the function of one variable
2. Demonstrate a working knowledge of vectors and vector functions
3. Determine partial derivatives of the functions of two or more variables
4. Illustrate the computational skills in finding the directional derivatives, Gradient vectors and differentials

UNIT 1: DERIVATIVES **18 Hrs.**

Small numerical quantities - Equations and Limits: Quadratic function, Cubic Function, Functions and limits, Graphical interpretation of derivatives, Derivatives and differentials, Integration and Antiderivatives - Function Types,

Differentiating Groups of functions: Sums of Functions, Function of a function, Function products, Function Quotients, Differentiating Implicit Functions –

Differentiating Exponential and Logarithmic Functions: Exponential functions, Logarithmic Functions, - Differentiating Trigonometric Functions: Differentiating Tan, Differentiating Csc, Differentiating Sec, Differentiating Cot, Differentiating ArcSin, Arccos and Arctan, Differentiating Arccsc, Arcsec and Arccot – Differentiating Hyperbolic functions: Differentiating Sinh, Cosh and Tanh, Higher Derivatives: Higher derivatives of a Polynomial, Identifying a Local Maximum or Minimum,

UNIT 2: VECTORS AND VECTOR FUNCTIONS **12 Hrs.**

Three dimensional coordinate systems, Vectors: Component form, Vector algebra operations,

The Dot Product: Angle between Vectors, orthogonal vectors, The Dot product properties and Vector Projections, Writing a vector as a sum of orthogonal vectors,

The cross product: The cross product of two vectors in space, box product - Vector functions: Limits and Continuity, Derivatives and Motion, Differentiation rules for vector functions, vector functions of constant length

UNIT 3: PARTIAL DERIVATIVES **12 Hrs.**

Partial Derivative: Partial Derivatives of function of two variables, Functions of more than two variables, Partial derivatives and continuity, second order partial derivatives, Partial derivatives of still higher order, Differentiability, Chain rule: Functions of two variables, Functions of three variables, Functions defined on Surfaces,

UNIT 4: DIRECTIONAL DERIVATIVE, GRADIENT VECTORS AND DIFFERENTIALS **18 Hrs.**

Directional Derivatives and Gradient Vectors: Directional Derivatives in the Plane, Interpretation of the Directional Derivative, Calculation of Gradients, Gradient and Tangents to Level Curves, Functions of

three variables.
Tangent Planes and differentials: Tangent planes and Normal lines, Estimating Change in specific direction, How to linearize the function of two variables, differentials, Total differentials - Estimating change in Volume, Sensitivity to change, Estimating percentage error

TEXT BOOKS

1. *J Vince, Foundation Mathematics for Computer Science a Visual Approach, Springer International Publishing, 2015. (Unit 1)*
2. *M. D. Weir, J. Hass and G B Thomas Jr.,. Giordano, Thomas' Calculus - Multivariable, 12th ed., Pearson, 2012.*

REFERENCE BOOKS

1. *J. Stewart, Multivariable calculus, 7th ed.: Belmont, USA: Brooks/Cole Cengage Learning., 2013.*
2. *M. Spivak, Calculus, 3rd ed., Cambridge University Press, 2006.*
3. *H Anton. Multivariable Calculus. J. Wiley, 1995.*

BDS232 - PROBABILITY AND DISTRIBUTION

Total Teaching Hours/Semester: 60
Max Marks: 100 **Credits: 4**

COURSE DESCRIPTION: This course is designed to teach the basic concepts of random variables and its generation functions. It also gives a brief idea about standard probability distributions and how they are applied in real time situations.

COURSE OBJECTIVE: To enable the students to understand the properties and applications of various probability functions.

COURSE OUTCOMES:

1. Demonstrate the random variables and its functions
2. Infer the expectations for random variable functions and generating functions.
3. Demonstrate various discrete and continuous distributions and their usage

UNIT 1: RANDOM VARIABLES **10 Hrs.**

Definition, Discrete and continuous random variables, Probability Mass function and Probability density function, Distribution function and its properties.

Two dimension random variables: Discrete and continuous type, Joint Density function, Marginal and conditional Probability Mass function and Probability Density function, independence of variables with illustration.

UNIT 2: MATHEMATICAL EXPECTATION AND GENERATING FUNCTIONS 10 Hrs.

Expectation of single and bivariate random variables and its properties. Moments and Cumulants, moment generating function, cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications, Conditional expectations.

UNIT 3: DISCRETE PROBABILITY DISTRIBUTIONS **15 Hrs.**

Discrete distributions: Binomial, Poisson, geometric, negative binomial, Hypergeometric distributions along with their properties, limiting/approximation cases and applications.

UNIT 4: CONTINUOUS PROBABILITY DISTRIBUTIONS **15 Hrs.**

Continuous distributions: Uniform, normal, exponential, Cauchy, beta and gamma distributions along with their properties, limiting/approximation cases and applications.

UNIT 5: LIMITING THEOREMS **10 Hrs.**

Chebyshev's inequality, Week Law of Large numbers, Strong Law of Large numbers and their applications, Central Limit Theorem for i.i.d variates and its application, De-Moivre Laplace theorem.

ESSENTIAL READING

1. *Rohatgi V.K and Saleh E, An Introduction to Probability and Statistics, 3rd edition, John Wiley & Sons Inc., New Jersey, 2015.*
2. *Gupta S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2014.*

RECOMMENDED READING

1. *Mukhopadhyay P, Mathematical Statistics, Books and Allied (P) Ltd, Kolkata, 2015.*
2. *Walpole R.E, Myers R.H, and Myers S.L, Probability and Statistics for Engineers and Scientists, Pearson, New Delhi, 2017.*
3. *Montgomery D.C and Runger G.C, Applied Statistics and Probability for Engineers, Wiley India, New Delhi, 2013.*
4. *Mood A.M, Graybill F.A and Boes D.C, Introduction to the Theory of Statistics, McGraw Hill, New Delhi, 2008.*

BDS233 - PRINCIPLES OF DATA SCIENCE

Total Teaching Hours for Semester: 60
Max Marks: 100 **Credits: 4**

COURSE DESCRIPTION: To provide strong foundation for data science and application area related to it and understand the underlying core concepts and emerging technologies in data science.

COURSE OBJECTIVES: To make the student learn the process of working with data in large scale. Make the student understand the existence of data with its wilderness and make use of it.

COURSE OUTCOMES:

1. Understand the fundamental concepts of data science
2. Evaluate the data analysis techniques for applications handling large data
3. Demonstrate data science process

UNIT 1: PREPARING AND GATHERING DATA AND KNOWLEDGE 10 Hrs.
Philosophies of data science - data all around us: the virtual wilderness - Data wrangling: from capture to domestication - Data science in a big data world - Benefits and uses of data science and big data - facts of data - data science processes

UNIT 2: OVERVIEW OF THE DATA SCIENCE PROCESS 10 Hrs.
Retrieving data - Cleansing, integrating, and transforming data - Exploratory data analysis - Build the model - Presenting finding and building applications on top of them

UNIT 3: MACHINE LEARNING 10 Hrs.
Modeling Process – Training model – Validating model – Predicting new observations –Supervised learning algorithms – Unsupervised learning algorithms

UNIT 4: FIRST STEPS IN BIG DATA 10 Hrs.
Distributing data storage and processing with frameworks - Case study: Assessing risk when loaning money - Join the NoSQL movement - Introduction to NoSQL - Case Study

UNIT 5: THE RISE OF GRAPH DATABASES 10 Hrs.
Introducing connected data and graph databases - Text mining and text analytics - text mining in real world - text mining techniques

UNIT 6: INTRODUCTION TO DATA VISUALIZATION 10 Hrs.
Data visualization options – Filters – Map Reduce – Dashboard development tools.

ESSENTIAL READING

1. *Think Like a Data Scientist, Brian Godsey, Manning Publications, 2017.*
2. *Introducing Data Science, Davy Cielen, Arno D. B. Meysman and Mohamed Ali, Manning Publications, 2016.*
3. *Introducing Data Science, Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Manning Publications Co., 1st edition, 2016*

REFERENCE BOOKS

1. *Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly, 1st edition, 2015.*
2. *Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil, Rachel Schutt, O' Reilly, 1st edition, 2013.*
3. *Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Cambridge University Press, 2nd edition, 2014*
4. *An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013*

BDS271 DATA STRUCTURE USING C

Total Teaching Hours/Semester: 90 Hrs
Max Marks: 150 **Credits: 5**

COURSE DESCRIPTION: Data Structure is considered as one of the fundamental paper towards a more comprehensive understanding of programming and application development. Student is expected to work towards a sound theoretical understanding of Data Structures and also compliment the same with hands on implementing experience using C.

COURSE OBJECTIVES: To make the students practically implement the data structures like stack, queue, array etc. Student will be able to understand and implement different searching and sorting techniques.

COURSE OUTCOMES:

1. Demonstrate their ability to understand the need of data structures while writing programs
2. Design and develop modular programs using relevant data structure operations in C
3. Able to build, test and debug small scale real-time applications using data structures in C

UNIT 1: C PROGRAMMING BASICS **10 Hrs.**

Structure of a C program – compilation and linking processes – Constants, Variables – Data Types – Expressions using operators in C – Managing Input and Output operations – Decision Making and Branching – Looping statements.
Arrays – Initialization – Declaration - String operations – String Arrays- Structures – Unions

UNIT 2: FUNCTIONS AND POINTERS **8 Hrs.**

Functions – Pass by value – Pass by reference – Recursion – Pointers – Definition – Initialization – Pointers arithmetic-Storage Class

UNIT 3: LINEAR DATA STRUCTURES **9 Hrs.**

Introduction to data structures-Arrays and its representations – Stacks and Queues – Linked lists – Linked list-based implementation of Stacks and Queues –Double and Circular Linked list

UNIT 4: NON-LINEAR DATA STRUCTURES **10 Hrs.**

Introduction-Binary Trees-Properties of Binary Trees-Binary Tree Representations-Binary Tre Traversals- Graphs - Introduction - Definition - representation - Depth first search - Breadth first search

UNIT 5: SERACHING AND SORTING ALGORITHMS **8 Hrs.**

Introduction -Linear Search-Binary Search- Insertion Sort - Selection Sort - Quick Sort - Merge Sort

LIST OF PROGRAMS FOR PRACTICALS **45 Hrs.**

1. Demonstrate the usage of operators and data types in C
2. Demonstrate the usage of conditional and looping statements
3. Demonstrate the concept of structures and unions
4. Implement pointer arithmetic operations
5. Write a program to insert and delete an element(s) in two dimensional arrays.
6. Write a program to implement Linear and Binary Search
7. Write a program to implement insertion sort.
8. Write a program to implement selection sort.
9. Write a program to implement quick sort using recursion
10. Write a program to implement merge sort using recursion.
11. Demonstrate linked list with crate, insert and delete operations
12. Write a program to implement of different operations on a stack using an array and linked list.
13. Write a program to implement different operations on a queue using arrays and linked list.
14. Write a program to create a binary search tree and to perform Insertion and different types of traversal
15. Implement breadth first search (bfs) and depth first search (dfs)

ESSENTIAL READING

1. *Let Us C,Yasvant Kanetkar, 16 th Edition,BPB Publications,2017*
2. *Fundamental of Data Structures in C, Horowitz Sahni Anderson-Freed, Universities Press, Reprint 2009.*

REFERENCE BOOKS

1. *Data Structures Using C, Reema Thareja, 2nd Edition, Oxford University Press Publications, 2014*
2. *Data Structures with C, Seymour Lipschutz, 1st Edition, McGraw Hill Education, 2017*
3. *Data Structures Through C, Yashwant Kanetkar, 9th Edition, BPB Publication 2010.*
4. *An Introduction to Data Structures with Applications, Tremblay J.P and Sorenson P.G, 2nd Edition, 2002, TMH*

BDS272 - PROGRAMMING IN R

Total Teaching Hours for Semester: 60
Max Marks: 100 **Credits: 4**

COURSE OBJECTIVES: The objective of this course is to provide comprehensive knowledge of paradigms of R programming language.

COURSE OUTCOMES:

1. Understanding the basic concepts of R
2. Apply the programming concepts of R for data analysis.
3. Build statistical model using R for data analysis.

UNIT 1: INTRODUCTION **5 Hrs.**

Introduction to R, How R works, Creating R objects, Displaying R objects, Deleting R objects, Converting Objects, Accessing the values of objects, the indexing system, accessing the values of an object with names.

UNIT 2: DATA WITH R **5 Hrs.**

Reading Data in a file, saving data, generating data- regular sequences and random sequences, the data Editor.

UNIT 3: BASIC COMPUTATION WITH R **5 Hrs.**

Arithmetic and simple functions, arrays, vectors and matrices computation.

UNIT 4: GRAPHICS WITH R **5 Hrs.**

Managing graphics, graphical functions, low-level plotting commands, graphical parameters, practical examples, the Grid and Lattice packages.

UNIT 5: STATISTICAL ANALYSES WITH R **5 Hrs.**

Packages for statistical analysis, analysis of variance, formulae, generic functions.

UNIT 6: PROGRAMING WITH R IN PRACTICE **5 Hrs.**

Loops and vectorization, writing your own functions, writing a Program in R.

LIST OF PROGRAMMES FOR PRACTICAL **30 Hrs.**

1. Implement in R Programing the concept to create a simple bar plot of five subjects marks.
2. Implement in R Programing the concept to create an array of two 3x3 matrices each with 3 rows and 3 columns from two given two vectors. Print the second row of the second matrix of the array and the element in the 3rd row and 3rd column of the 1st matrix.
3. W Implement in R Programing the concept to extract 3rd and 5th rows with 1st and 3rd columns from a given data frame.
4. W Implement in R Programing the concept to create a data frame using two given vectors and display the duplicated elements and unique rows of the said data frame.
5. Implement in R Programing the concept to rotate a given matrix 90 degree clockwise rotation.
6. Create the vector (x1 + 2x2 − x3, x2 + 2x3 − x4, . . . , xn−2 + 2xn−1 − xn)
7. Implement in R Programing the concept to find Sum, Mean and Product of a Vector, ignore element like NA or NaN.
8. Implement in R Programing the concept to create a list of dataframes and access each of those data frames from the list.
9. Reading the data into R and apply Simple statistics on it with required graphs.
10. Take any dataset and perform following operations on it.
11. Basic row manipulations
12. Advanced row selection
13. Basic column operations
14. Permanently changing the column order
15. Adding and removing new columns
16. Adding new columns; Advanced
17. Counting observations
18. Working with keys and subsetting
19. Selecting existing columns and reshaping
20. Implement in R Programing the concept of matrix multiplication and addition.
21. Implement in R Programing the concept of linear correlation.
22. Implement in R Programing the concept of one sample and two sample t-test.
23. Implement in R Programing the concept Simple linear regression.
24. Implement in R Programing the concept multilinear correlation

ESSENTIAL READING

1. *William N. Venables and David M. Smith, An Introduction to R. 2nd Edition. Network Theory Limited.2019*
2. *Emmauel Paradis, R for Beginners. Pearson, 2005.*

RECOMMENDED READING

1. *Statistics: An Introduction Using R, Michael J. Crawley, WILEY, Second Edition, 2015.*
2. *R for everyone, Jared Lander, Pearson, 1st Edition, 2014*

THIRD SEMESTER

BDS331 - GRAPH THEORY

Total Teaching Hours for Semester: 60
Max Marks: 100 **Credits: 4**

COURSE OBJECTIVES/COURSE DESCRIPTION: This course aims at introducing the students to elementary concepts in Graph Theory.. It includes the topic on basic Graph terminologies, models, representations, isomorphism, connectivity, Euler and Hamiltonian paths, Graph colorings and trees.

COURSE OUTCOMES:

1. Demonstrate all the basic terminologies on Graphs
2. Diagrammatically represent a graph and analyze various graph models
3. Analyze the interconnectivity between the nodes of the graphs
4. Illustrate the idea of coloring the vertices of the Graph
5. Have an enhanced understanding of the trees and its applications

UNIT 1: GRAPHS **15 Hrs.**

Graphs and Graph Models: Graphs, Infinite graphs, finite graphs, simple graphs, multigraphs, pseudographs, directed graphs, mixed graphs,
Graph Models: Social Networks, communication networks, Information networks, software design applications, transportation networks,
Graph Terminology: Basic Terminology, Some special simple graphs, Bipartite graphs, Bipartite graphs and Matchings, Some applications of special types of graphs, New graphs from old, degree sequence of graphs, graphic, n-regular graph, complementary graph,

UNIT 2: GRAPH REPRESENTATION, ISOMORPHISM AND CONNECTIVITY 15 Hrs.

Representing graphs, Adjacency Matrices, Incidence Matrices
Graph Isomorphism: Isomorphism of Graphs, Determining whether two simple graphs are Isomorphic,
Connectivity: Paths, walk, closed walk, trail, connectedness in undirected graphs, cut vertices, cut bridge, vertex connectivity, edge connectivity, connectedness in directed graphs, counting paths between the vertices.

UNIT 3: SHORTEST-PATH PROBLEMS AND GRAPH COLORINGS **15 Hrs.**

Euler paths and circuits, Hamiltonian paths and Circuits, Applications and Hamiltonian circuits: Gray codes,
Shortest-Path Problems: Dijkstra's algorithm, Floyd's Algorithm, the traveling salesman problem,
Planar graphs: Euler's formula,
Graph colorings and its applications.

UNIT 4: INTRODUCTION TO TREES **15 Hrs.**

Tree, Rooted tree, Trees as models, properties of trees, Applications of trees: Binary search trees, Decision trees, Prefix codes, Game trees,
Tree traversal: Universal address systems, Infix, prefix, and postfix notation, Spanning trees, Depth-first search, Breadth-first search, Backtracking applications, Depth-first search in directed graphs, Algorithms for minimum spanning trees.

TEXT BOOKS

1. *K. H. Rosen, Discrete Mathematics and its Applications, 7th ed., McGraw – Hill, 2012.*

REFERENCE BOOKS

1. *N Deo, Graph Theory with Applications to Engineering and Computer Science. Dover Publications, Inc., 2017.*
2. *J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Application to Computer Science, Rep rint, India: Tata McGraw Hill Education, 2008.*

BDS332 - STATISTICAL INFERENCES

Total Teaching Hours/Semester: 45
Max. Marks: 100 **Credits: 3**

COURSE DESCRIPTION: This course is designed to introduce the concepts of theory of estimation and testing of hypothesis. This paper also deals with the concept of parametric tests for large and small samples. It also provides knowledge about non-parametric tests and its applications.

COURSE OBJECTIVE: To enable the students to give inference about the population based on sample statistic.

COURSE OUTCOMES:

1. Demonstrate the concepts of point and interval estimation of unknown parameters and their significance using large and small samples.
2. Apply the idea of sampling distributions of difference statistics in testing of hypotheses.
3. Infer the concept of nonparametric tests for single sample and two samples.

UNIT 1: INTRODUCTION **15 Hrs.**

Concept of Population, Sample, Sample Space, Parameter and Statistic, Parameter Space, Sampling distribution of a statistic, Standard error. Derivation of Standard Error of sample mean, variance, proportion and difference between variances. Concept of Order Statistics.

UNIT 2: THEORY OF ESTIMATION **15 Hrs.**

Point Estimation: Concept of Estimator and Estimate, properties of Point estimator – Unbiasedness, Consistency, efficiency, relative efficiency, Minimum variance unbiased estimators, sufficiency, Crammer Rao Inequality (Statement only), Rao Blackwell Theorem (Statement only), Neyman Factorization Theorem (Statement only). Methods of Estimation: Maximum likelihood, least squares and minimum variance. Concept of Interval Estimation.

UNIT 3: TESTS OF SIGNIFICANCE I **15 Hrs.**

Concept of Statistical hypotheses, Type I and Type II error, Critical Region and power of the test. Neyman-Pearson lemma (Statement only). Large sample tests: Tests for single mean, equality of two means, single variance and equality of two variance for normal population, Tests of proportions.

UNIT 4: TESTS OF SIGNIFICANCE II **15 Hrs.**

Sampling distributions of Chi-square, t and F statistics: derivation of Mean, variance, M.G.F and properties. Small sample tests: Tests for single mean, equality of two means, single variance and equality of two variance, Tests of proportions based on t and F statistics. Chi-square tests for independence of attributes and goodness of fit.

UNIT 5: NONPARAMETRIC TESTS **15 Hrs.**

Concept of Nonparametric tests, Run test for randomness, Sign test and Wilcoxon Signed Rank Test for one and paired samples. Run test, Median test and Mann-Whitney-Wilcoxon tests for two samples.

ESSENTIAL READING

1. *Rohatgi V.K an Saleh E, An Introduction to Probability and Statistics, 3rd edition, John Wiley & Sons Inc, New Jersey, 2015.*
2. *Gupta S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2014.*

RECOMMENDED READING

1. *Walpole R.E, Myers R.H and Myers S.L, Probability and Statistics for Engineers and Scientists, 9th edition, Pearson, New Delhi, 2017.*
2. *Mukhopahyay P, Mathematical Statistics, Books and Allied (P) Ltd, Kolkata, 2015*
3. *Rajagopalan M and Dhanavanthan P, Statistical Inference, PHI Learning (P) Ltd, New Delhi, 2012.*
4. *Conover W.J, Practical Nonparametric Statistics, 3rd edition, Wiley International, 1999.*

BDS333 - DATABASE MANAGEMENT SYSTEM

Total Teaching Hours for Semester: 60
Max Marks: 100 **Credits: 4**

COURSE DESCRIPTION: This course concentrates on introduction, principles, design and implementation of DBMS. It introduces about the distributed system and brief about data mining and data warehouse.

COURSE OBJECTIVE: To provide strong foundation of database concepts and develop skills for the design and implementation of a database application with a brief exposure to advanced database concepts.

COURSE OUTCOMES:

1. Understanding the core terms, concepts, and tools of relational database management systems.
2. Analyzing database design and logic development for database programming.

UNIT 1: INTRODUCTION **10 Hrs.**

Data, Database, Database management system, Characteristics of the database approach,
Role of Database administrators, Role of Database Designers, End Users, Advantages of Using a DBMS and When not to use a DBMS.
DBMS Architecture
Data Models – Categories of data models, Schemas, Instances, and Database states.
DBMS Architecture and Data Independence – The Three schema architecture, Data independence DBMS Languages and Interfaces.Classifications of Database Management Systems.

UNIT 2: DATA MODELING USING ENTITY-RELATIONSHIP MODEL **10 Hrs.**

Using High Level Conceptual Data Models for Database Design, Example Database applications. Entity types, Entity Sets, Attributes and Keys.
Relationships, Relationship types, Roles and Structural constraints. Weak Entity Types and Drawing E-R Diagrams.
Index Structures for Files
Single Level Ordered Indexes – Primary indexes, Clustering indexes and Secondary indexes.
Multi- level indexes, Hashing concepts.

UNIT 3: RELATIONAL DATA MODEL **10 Hrs.**

Relation, Integrity constraints - domain, entity and Referential integrity constraints, Basic Relational Algebra operations, select, project and join operations.
Database Design
Functional dependencies and Normalization for Relational Databases - Normalization concepts, first,second, third normal forms, Boyce-Codd normal form.

UNIT 4: SQL **10 Hrs.**

SQL data definition and data types, specifying constraints in SQL, schema change statements, Basic queries, More Complex SQL queries, INSERT, DELETE and UPDATE statements in SQL, Views – Concept of a view in SQL.
Transaction Processing Concepts and Concurrency Control Techniques
Transaction and System concepts – Desirable properties of Transactions – Schedules and

Recoverability. Lock-Based Protocols – Locks, Granting of Locks, and Two phase locking protocol and implementation of locking.

UNIT 5: DATA BASE ADMINISTRATION **10 Hrs.**

Introduction to Database security issues, Discretionary Access Control Based on Granting/Revoking of Privileges and Multi-level security.

Database Recovery

Recovery Concepts: Recovery Outline and Categorization of Recovery Algorithms, Caching Buffering of Disk Blocks, Write-Ahead Logging, Steal/No-Steal, and Force/No-Force, Checkpoints in the System log and Fuzzy Check pointing, Transaction Rollback.

UNIT 6: DISTRIBUTED DATABASES **10 Hrs.**

Distributed database concepts, Data fragmentation, Replication, and Allocation Techniques for Distributed database design, Types of Distributed database systems.

Introduction to Advanced Database concepts

Brief introduction to Data warehousing and Data mining.

DISTRIBUTED DATABASES

1. *ElmasriRamez and NavatheShamkant B, Fundamentals of Database Systems, Addison-Wesley, 6th Edition, 2010.*

ESSENTIAL READING / RECOMMENDED READING

1. *Silberschatz, Korth, Sudarshan, Database System Concepts, 5 Edition, McGraw Hill, 2006.*
2. *O`neil Patricand, O`neil Elizabeth, Database Principles, Programming and Performance, 2nd Edition, Margon Kaufmann Publishers Inc, 2008.*

BDS334 – PROFESSIONAL ETHICS IN COMPUTING

Total Teaching Hours for Semester: 30Hrs
Max Marks: 50 **Credits: 2**

COURSE DESCRIPTION: The course concentrates on the theory and practice of computer ethics. The aim of the course is to study the basis for ethical decision-making and the methodology for reaching ethical decisions concerning computing matters.

COURSE OBJECTIVES: The student will be able to describe and distinguish between the various ethical theories which can be used to form the basis of solutions to moral dilemmas in computing. Identify and comprehend the ethical responsibilities within computer science, cyber technology, and information technology. Recognize the professional codes of conduct within cyber technology. Recognize new frontiers within computer science and the relationship to present ethical standards.

COURSE OUTCOMES:

1. Understand the values and principles concerning ethics and personality development
2. Exhibit leadership qualities in ethic and profession

UNIT 1: INTRODUCTION TO ETHICS **8 Hrs.**
Subjective & Cultural Relativism - Divine Command Theory - Ethical Egoism - Kantianism - Act & Rule Utilitarianism -Social Contract Theory - Virtue Ethics - Morality of Breaking the Law

UNIT 2: NETWORKED COMMUNICATIONS **8 Hrs.**
Spam - Internet Interactions - Text Messaging - Censorship - Freedom of Expression - Child and Inappropriate Content - Breaking Trust - Internet Addiction

UNIT 3: INTELLECTUAL PROPERTY **7 Hrs.**
Intellectual Property Rights - Protecting Intellectual Property - Fair Use – Peer-to-Peer Networks and Cyber lockers - Protection of Software - Open Source Software - Information Privacy

UNIT 4: PRIVACY AND PROFESSIONAL ETHICS **7 Hrs.**
Privacy and the Government - Computer Network Security - How well developed are the Computing Professions? - Software Engineering code of Ethics - Analysis of code - Whistle Blowing - Globalization – Plagiarism.

ESSENTIAL READING

1. *Ethics for the Information Age, Michael J. Quinn, Pearson Publications, 6th Edition, 2015*
2. *Ethics for the Information Age, Michael J. Quinn, Pearson Publications, 8th Edition, 2020*

REFERENCE BOOKS

1. *The handbook of Information and Computer Ethics, Kenneth Einar Himma and Herman T. Tavani, Wiley Publications, 2010.*
2. *Readings & Cases in Information Security: Law & Ethics, Michael E. Whitman, Herbert J. Mattord, Cengage Learning, 2010*

WEB RESOURCES

1. *http://www.cs.fsu.edu/~langley/CIS3250/2019-Summer/index.html*
2. *https://www.cs.princeton.edu/courses/archive/spr96/cs291/syllabus.html*

BDS351 - GRAPH THEORY LAB USING PYTHON

Total Teaching Hours for Semester: 30
Max Marks: 50 **Credits: 2**

COURSE OBJECTIVES/COURSE DESCRIPTION: This course aims at introducing the students to elementary concepts in Graph Theory. It includes the topic on basic Graph terminologies, models, representations, isomorphism, connectivity, Euler and Hamiltonian paths, Graph colourings and trees.

COURSE OUTCOMES:

1. Demonstrate all the basic terminologies on Graphs
2. Diagrammatically represent a graph and analyze various graph models
3. Analyze the interconnectivity between the nodes of the graphs
4. Illustrate the idea of coloring the vertices of the Graph
5. Have an enhanced understanding of the trees and its applications

LIST OF PROGRAMMES FOR PRACTICALS:

1. Introduction to NetworkX package in Python
2. Diagramatic Representation of Simple undirected graph
3. Adjacency matrix
4. Edgelist matrix
5. Adjacency list
6. Depth-First Traversal
7. Breadth-First Traversal
8. Dijkstra’s algorithm
9. Prims and Kruskal's algorithm
10. Degree Centrality

TEXT BOOK

1. *M Z Al-Taie and S Kadry, Python for Graph and Network Analysis, Springer International Publishing, 2019.*

REFERENCE BOOKS

1. *P A Knight, A first course in Network Theory, Oxford University Press, 2019.*
2. *A Boschetti, L Massaron, Python Data Science Essentials, Packt Publishing Limited, 2015.*

BDS352 - STATISTICAL INFERENCES USING PYTHON

Total Teaching Hours/Semester: 30
Max. Marks: 50 **Credits: 2**

COURSE DESCRIPTION: This course is designed to introduce the concepts of theory of estimation and testing of hypothesis. This paper also deals with the concept of parametric tests for large and small samples. It also provides knowledge about non-parametric tests and its applications.

COURSE OBJECTIVE: To enable the students to give inference about the population based on sample statistic.

COURSE OUTCOMES:

1. Demonstrate the concepts of point and interval estimation of unknown parameters and their significance using large and small samples.
2. Apply the idea of sampling distributions of difference statistics in testing of hypotheses.
3. Infer the concept of nonparametric tests for single sample and two samples.

PRACTICAL ASSIGNMENTS USING R PROGRAMMING:

1. Test for mean and equality of two means when variance is known under normality conditions.
2. Test for single mean when variance is unknown under normality conditions.
3. Test for equality of two means when variance is unknown under normality conditions.
4. Test for single proportion and equality of two proportions.
5. Test for variance and equality of variances under normality conditions.
6. Test for independence of attributes using Chi-Square test.
7. Test for goodness fit using Chi-Square test.
8. Test for one sample using Run test and sign test.
9. Test for paired samples using Wilcoxon Signed Rank test
10. Test for two samples using Run test, Median test and Mann-Whitney-Wilcoxon test.

ESSENTIAL READING

1. *Rohatgi V.K an Saleh E, An Introduction to Probability and Statistics, 3rd edition, John Wiley & Sons Inc, New Jersey, 2015.*
2. *Gupta S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2014.*

RECOMMENDED READING

1. *Walpole R.E, Myers R.H and Myers S.L, Probability and Statistics for Engineers and Scientists, 9th edition, Pearson, New Delhi, 2017.*
2. *Mukhopahyay P, Mathematical Statistics, Books and Allied (P) Ltd, Kolkata, 2015*
3. *Rajagopalan M and Dhanavanthan P, Statistical Inference, PHI Learning (P) Ltd, New Delhi, 2012.*
4. *Conover W.J, Practical Nonparametric Statistics, 3rd edition, Wiley International, 1999.*

BDS371 – APPLIED EXCEL

Total Teaching Hours/Semester: 60
Max Marks: 60 **Credits: 3**

COURSE DESCRIPTION: This course is designed to build the logical thinking ability and to provide hands-on experience in solving statistical models using MS Excel with Problem based learning. To explore and visualize data using excel formulas and filters.

COURSE OBJECTIVE: To enable the students to work with different kinds of data into excel.

COURSE OUTCOMES:

1. Demonstrate the logics of using excel features.
2. Analyze the given problem and solve using Excel.
3. Infer the building blocks of excel, excel shortcuts, sample data creation and analyzing data.

UNIT 1: INTRODUCTION **10 Hrs.**

File types, Spreadsheet structure, Menu bar, Quick access toolbar, Mini toolbar, Excel options.
Formatting: Format painter, Font, Alignment, Number, Styles, Cells, Clear, Page layout. Overview of Excel tables and properties, Collecting sample data and arranging in definite format in excel tables, data validation, using form for data entry, Secondary data collection from different databases.

UNIT 2: **15 Hrs.**

Importing data from different sources - text file, web page and XML file, Exporting data in different formats - text, csv, image, pdf etc,
Creating database with the imported data.
Data tools: text to column, identifying and removing duplicates, using format cell options, Application of functions - Concatenate, upper, lower, year, month, day, text, year, Examples of using named ranges in SUM, AVERAGE

UNIT 3: **10 Hrs.**

Data manipulation in table using shortcuts, using formulas and function, Missing value handling in Graph using example of scatter graph with connecting line. LOOKUP, VLOOKUP, HLOOKUP, INDEX, MATCH.

UNIT 4: **10 Hrs.**

Getting started with data analysis toolpak, descriptive statistics (using basic functions and data analysis toolpak), correlation, linear regression, one way ANOVA (with interpretations).

UNIT 5: **15 Hrs.**

Introduction to macros, using macros for data entry, importing files, Data cleaning and managing using macro, Different types of security available in Excel to protect the contents.

ESSENTIAL READING

1. *Walkenbach J, Microsoft Excel 2013*
2. *Bible: The Comprehensive Tutorial Resource, Wiley India Pvt Ltd, New Delhi, 2016.*

RECOMMENDED READING

1. *Olafusi M, Microsoft Excel and Business Data Analysis for the Busy Professional, Create Space Independent Publishing Platform, 2016.*
2. *Alexander M, Excel 2016 formulas, Wiley India Pvt Ltd, New Delhi, 2016.*
3. *McFedries P, Excel Data Analysis Visual Blueprint, 4th Edition, Wiley India Pvt Ltd, New Delhi, 2013.*

WEB LINKS

1. *www.excelfunctions.net*
2. *www.excel-easy.com*

BDS372 - PROGRAMMING IN JAVA

Total Teaching Hours for Semester: 120
Max Marks: 200 **Credits: 6**

COURSE DESCRIPTION: This course teaches students how to develop java applications. Course gives an overview of difference between C++ and Java. Students will be developing and testing java application as a practical course work. The course introduces the concept of JDBC in java using SWING and client-server communication using servlets.

COURSE OBJECTIVES: To introduce concepts of core java in a methodical way.
To understand the principles underlying the design of object oriented programming languages.

COURSE OUTCOMES:

1. Demonstrate their ability to understand the concepts of Object oriented programming and will model the real world applications using Object Oriented Programming concepts
2. Apply the concept of Multithreading in concurrent programming.
3. Able to Analyze & Design the concept of Event Handling and Swing
4. Build Client-Server communication using Servlet

UNIT 1: JAVA FUNDAMENTALS **10 Hrs.**

The origins of java - java's lineage C and C++ - how java impacted the internet - java bytecode – object oriented programming concepts - a first simple program - the java keywords - identifiers in java - the java class libraries.

Introducing data types and operators

Why data types are important - java's primitive types - literals - a closer look at variables - the scope and lifetime of variables - operators - type conversion in assignments - casting incompatible types - operator precedence -expressions.

Program control statements

Input characters from the keyboard - if statement - switch statement - for loop - the enhanced for loop - the while loop - the do-while loop – break – continue - nested loops.

UNIT 2: ARRAYS, STRINGS AND EXCEPTIONS **10 Hrs.**

Arrays: One dimensional arrays - multidimensional arrays - irregular arrays - alternative array declaration syntax - assigning array references - using the length member- the for each style for loop – command line arguments.

Strings: Constructing strings - operating on strings - arrays of strings - strings are immutable - using a string to control a switch statement - different string handling functions.

Exception handling: The exception hierarchy - exception handling fundamentals - the consequences of an uncaught exception - using multiple catch statements - catching subclass exceptions - try blocks can be nested - throwing an exception - using finally -using throws - java's built in exceptions - creating exception subclasses.

UNIT 3: CLASSES AND INHERITANCE **10 Hrs.**

Introducing Classes, Objects and Methods

Class fundamentals - how objects are created - reference variables and assignment - methods returning a value - using parameters - constructors - parameterized constructors - the new operator revisited - garbage collection - the this keyword - controlling access to class members - method overloading -

overloading constructors - understanding static - introducing nested and inner classes.
Inheritance
Inheritance basic - member access and inheritance - constructors and inheritance - using super to call superclass constructors - using super to access superclass members - creating a multilevel hierarchy - superclass references and subclass objects - method overriding - using abstract classes -using final - the object class

UNIT 4: INTERFACES, USING I/O AND MULTI THREADING 10 Hrs.
Packages and Interfaces
Packages - packages and member access - understanding protected members -importing packages - Interfaces - implementing interfaces - using interface references - variables in interfaces - interfaces can be extended - default interface methods - use static methods in an interface.

Using I/O
Java's I/O is built upon streams - byte streams and character streams - the byte stream classes - the character stream classes - the predefined streams-using the byte streams - reading and writing files using byte streams - reading and writing binary data, using java's character based streams - file I/O using character streams.

Multithreaded programming
Multithreading fundamentals - the thread class and runnable interface - creating a thread - creating multiple threads - determining when a thread ends -thread priorities - synchronization - suspending, resuming, and stopping threads.

UNIT 5: SWING 10 Hrs.
Introducing swing - the origins and design philosophy of swing - components and containers - layout managers - swing event handling - use of JButton -work with JTextField - create a JCheckBox - work with JList.

Self-Study
Advanced components using SWING

UNIT 6: DATABASE AND CLIENT-SERVER COMMUNICATION 10 Hrs.
Introduction to JDBC-JDBC Drivers & Architecture-CURD operation Using JDBC- Connecting to non-conventional Databases-Web Application Basics- Architecture and challenges of Web Application-Introduction to servlet- Servlet life cycle- Developing and Deploying Servlets- Exploring Deployment --Descriptor (web.xml)- Handling Request and Response

ESSENTIAL READING

1. *Java ™ A Beginner's Guide, Herbert Schildt, McGraw-Hill Education, 7th Edition, 2017*

REFERENCE BOOKS

1. *Schildt Herbert, Java :The Complete Reference, Tata McGraw- Hill, 10th Edition,2017*
2. *Dr.Rao,Nageswara ,Core Java,An Integrated Approach ,New Edition Kongent Solutions Inc, 2009.*

LIST OF PROGRAMMES FOR PRACTICAL **60 Hrs.**

1. To implement different entry controlled and exit controlled looping statements
2. To Implement nesting of switch statement
3. To Implement single and multi-dimensional arrays
4. To implement constructor overloading and method overloading
5. To implement static keyword
6. To Implement multilevel inheritance with super and this keyword
7. To implement abstract and final keyword
8. To implement methods of String class
9. To Implement exception handling and custom exceptions
10. To implement package and interface
11. To Implement multithreading
12. To implement scientific calculator using swings

FOURTH SEMESTER

BDS431 - LINEAR ALGEBRA

Total Teaching Hours for Semester: 60
Max Marks: 100 **Credit 4**

COURSE OBJECTIVES/COURSE DESCRIPTION: This course aims at enabling the problem solving skills on the mathematical concepts of linear algebra, analytical geometry and matrix decompositions that are relevant for data science.

COURSE OUTCOMES:

1. Use Linear equations, vector spaces, linear independence and linear mappings
2. Demonstrate problem solving skills Norms, Inner products, length and distances, angles and orthogonality, orthonormal basis, orthogonal complement, inner product spaces, orthogonal spaces, orthogonal projections, rotations
3. Understand and apply Determinant and trace, eigenvalues and eigenvectors
4. Implement cholesky decomposition, Eigen decomposition and singular value decomposition.

UNIT 1: LINEAR ALGEBRA **15 Hrs.**

Solving Systems of Linear Equations: Compact Representation of Systems of Linear Equations, Particular and General solutions,

Elementary Transformations: Augmented Matrix, Row-Echelon form, Reduced Row Echelon Form, The minus one trick, Calculating an Inverse by Gauss Elimination method - Vector Spaces: Groups, General Linear Groups, Vector Space, Vector Subspaces –

Linear Independence: Linear Combination, Linearly Dependent Vectors,

Basis and Rank: Generating Set and Basis, Rank –

Linear Mappings: Linear Transformation, Injective, surjective and bijective linear mappings, Homomorphism, Isomorphism, Endomorphism, Automorphism, Matrix representation of Linear Mappings, Basis Change, Image and Kernel of a Linear Mapping, Rank Nullity Theorem.

UNIT 2: ANALYTIC GEOMETRY **15 Hrs.**

Norms: Manhattan Norm, Euclidean Norm - Inner Products: Dot Product, General Inner Product, Inner Product that is not a dot product, Symmetric positive definite matrices –

Length and distances: Distance and Metric –

Angles and Orthogonality: Angle between vectors,

Orthogonality - Orthonormal Basis - Orthogonal Complement –

Inner Product spaces: Inner Product functions –

Orthogonal Projections: Projections onto one dimensional subspaces, Projection onto General Subspaces, Gram-Schmidt Orthogonalization –

Rotations: Rotations in R2 , Rotations in R3 , Rotations in n-dimensions, Properties of Rotations.

UNIT 3: DETERMINANT, EIGENVALUES AND EIGENVECTORS **15 Hrs.**

Determinant and Trace: Testing for Matrix Invertibility, Determinants as a Measure of Volume, Laplace Expansion, trace of a square Matrix, Characteristic Polynomial –

Eigenvalues and Eigenvectors: Eigenvalues, Eigenvectors, Collinearity and codirection, eigenvalue and characteristic polynomial, eigenspace and eigenspectrum, geometric multiplicity of eigenvalue,

Graphical intuitions (in two dimensions)of determinants, eigenvectors and eigenvalues, Eigen spectrum of Biological neural network, Determinants, trace and eigenvalues, Webpages as Eigenvectors (Google's Page Rank).

UNIT 4: MATRIX DECOMPOSITIONS **15 Hrs.**

Cholesky Decomposition: Cholesky Factorization -
Eigendecomposition and Diagonalization:
Eigendecomposition, Geometric intuition of Eigendecomposition, Singular Value Decomposition (SVD): SVD,
Geometric Intuition of the SVD, Vectors and SVD, Construction of SVD, Computing the SVD, Eigenvalue decomposition versus Singular Value Decomposition, Matrix Approximation, Spectral norm of a Matrix, Finding Structure in Movie Ratings and Consumers.

TEXT BOOKS

1. *M P Deisenroth, A A Faisal, C S Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.*

REFERENCE BOOKS

1. *P S Boyd, L Vandenberghe, Introduction to Applied Linear Algebra: Vectors, Matrices, and Least Squares. Cambridge University Press, 2018.*
2. *S. H. Friedberg, A. Insel, and L. Spence, Linear Algebra, 4th ed., Pearson, 2015.*
3. *V. Krishnamurthy, V. P. Mainra, and J. L. Arora, An introduction to linear algebra. New Delhi, India: Affiliated East East-West Press Pvt Ltd., 2003.*
4. *K. Hoffmann and R. A. Kunze, Linear algebra, 2nd ed., PHI Learning, 2014.*
5. *David C. Lay, Linear Algebra and its Applications, 3rd ed.-Indian Reprint, Pearson Education Asia, 2007.*
6. *S. Lang, Introduction to Linear Algebra, 2nd ed., New York: Springer-Verlag, 2005.*
7. *Gilbert Strang, Linear Algebra and its Applications, 4th ed., Thomson Brooks/Cole, 2007.*

BDS432 - SAMPLING TECHNIQUES

Total Teaching Hours/Semester: 45
Max Marks: 100 **Credits: 3**

COURSE DESCRIPTION: This course designed to introduce students about official statistical system in India and to understand basic concepts of Sampling and surveys.

COURSE OBJECTIVE: To enable the students to understand various sampling techniques and their application in various research studies.

COURSE OUTCOMES:

1. Demonstrate the official Statistical System in India.
2. Demonstrate various sampling techniques and their application
3. Infer various sampling error and non-sampling error.

UNIT 1: INTRODUCTION TO SAMPLING THEORY **9 Hrs.**

Concepts of population and sample. Complete enumeration vs. sampling. Planning of Sampling Survey. Types of sampling: non-probability and probability sampling, basic principle of sample survey population mean, total and proportion, variances of these estimates and sample size determination, Sampling and non-sampling errors, determination of sample size.

UNIT 2: SIMPLE RANDOM SAMPLING **9 Hrs.**

Simple Random Sampling: Probability of selecting any specified unit in the sample, selection of simple random sample, simple random sample from population with given frequency distribution, SRS of attribute, size of simple random sample for specified precision. Concept of SRSWOR and SRSWR.

UNIT 3: STRATIFIED RANDOM SAMPLING AND SYSTEMATIC SAMPLING **9 Hrs.**

Stratified random sampling: Technique, estimates of population mean and total, variances of these estimates. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates (N=nxk).Comparison of systematic sampling with SRS and stratified sampling.

UNIT 4: CLUSTER SAMPLING **9 Hrs.**

Cluster Sampling: Cluster sampling estimation of population mean and its variance. Relative efficiency of cluster sampling with SRS in terms of intra class correlation, comparison with SRS, stratified sampling method and their applications. Some Scaling Procedures.

UNIT 5: OFFICIAL STATISTICAL SYSTEM **9 Hrs.**

Present Official Statistical System in India relating to census of population, agriculture, industrial production, and prices; methods of collection of official statistics, their reliability and limitation and the principal publications containing such statistics. Also the various agencies responsible for the data collection- C.S.O., N.S.S.O., Office of Registrar General, their historical development, main functions and important publications.

REFERENCE BOOKS

1. *Cochran W.G, Sampling Techniques, 3rd Edition, John Wiley and Sons, New York, 2008.*
2. *Gupta S.C and Kapoor V.K, Fundamentals of Applied Statistics, 4th Edition (Reprint), Sultan Chand and Sons, India 2018.*

RECOMMENDED READING

1. *Mukhopadhyay P, Theory and Methods of Survey Sampling, 2nd Revised edition, PHI Learning New Delhi, 2008.*
2. *Arnab R, Survey Sampling Theory and Applications, Academic Press, UK, 2017.*
3. *Goon A.M, Gupta M.K and Dasgupta B, Fundamentals of Statistics (Vol.2), World Press 2005.*
4. *Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.*

BDS433 - OPERATING SYSTEM

Total Teaching Hours/Semester: 60
Max Marks: 100 Credits: 4

COURSE DESCRIPTION: This course is an introduction to the concepts behind modern computer operating systems. Topics will include what an operating system does (and doesn't) do, system calls and interfaces, processes, resource scheduling and management (of the CPU, memory, etc.), virtual memory.

COURSE OBJECTIVE: To acquire the fundamental knowledge of the operating system architecture and its components. To know the various operations performed by the operating system

COURSE OUTCOMES:

1. Demonstrate the fundamentals of an operating system
2. Evaluate the importance of process and scheduling
3. Analyze and solve the issues in synchronization and memory management

UNIT 1: INTRODUCTION AND SYSTEM STRUCTURES JAVA FUNDAMENTALS **10 Hrs.**

Operating System Fundamentals- Computer System organization and architecture- Operating System structure and operations- Basics of process- memory and storage management and protection and security- Operating System services- User interface- System calls- System programs- Operating System structure- System boot.

UNIT 2: PROCESS MANAGEMENT **10 Hrs.**

Process concept- Process scheduling- Operations on processes- Inter Process Communication- Overview of Threads- Multi-threading models- Threading issues

UNIT 3: PROCESS SYNCHRONIZATION **10 Hrs.**

Need of synchronization- Critical section problems- Peterson‘s solution- Synchronization hardware- Mutex Locks- Semaphores- Classical problems of synchronization- Synchronization examples- Thread synchronization using mutex and semaphore.

UNIT 4: CPU SCHEDULING **10 Hrs.**

CPU Scheduling concepts- Scheduling criteria- Scheduling algorithms- Overview of thread scheduling- Multi-processor scheduling

UNIT 5: MEMORY MANAGEMENT **10 Hrs.**

Overview- Swapping- Memory allocation- Segmentation- Paging- Structure of the page table

UNIT 6: VIRTUAL MEMORY **10 Hrs.**

Overview- Demand paging- Copy on Write- Page replacement- Allocation of Frames- Thrashing

Self Learning
File system structure, Directory structure

REFERENCE BOOKS

1. *Silberschatz, P.B. Galvin and G. Gagne, Operating System Concepts.9th Edition, New Delhi: Wiley India, 2011.*

RECOMMENDED READING

1. *Stalling William, Operating Systems: Internals and Design Principles. 7th Edition, Prentice Hall, 2011.*
2. *Dietel et al, Operating System.3rd Edition. Pearson Education, 2004.*
3. *A.S. Tanenbaum, Modern Operating Systems.3rd Ed, Prentice Hall, 2007.*

BDS434 - SOFTWARE ENGINEERING

Total Teaching Hours for Semester: 45
Max Marks: 100 **Credits: 3**

COURSE OBJECTIVES/COURSE DESCRIPTION: To be aware of Different life cycle models; Requirement dictation process; Analysis modelling and specification; Architectural and detailed design methods; Implementation and testing strategies; Verification and validation techniques; Project planning and management and Use of CASE tools.

COURSE OUTCOMES:

1. Implement the different life cycle models.
2. Demonstrate the ability to manage a project including planning, scheduling and risk assessment/management.
3. Demonstrate and evaluate software development cost estimation.

UNIT 1: SOFTWARE PROCESS **9 Hrs.**

Introduction –S/W Engineering Paradigm – life cycle models (water fall, incremental, spiral, WINWIN spiral, evolutionary, prototyping, object oriented) - system engineering – computer based system – verification – validation – life cycle process – development process
–system engineering hierarchy.

UNIT 2: SOFTWARE REQUIREMENTS **9 Hrs.**

Functional and non-functional - user – system –requirement engineering process – feasibility studies – requirements – elicitation – validation and management – software prototyping – prototyping in the software process – rapid prototyping techniques – user interface prototyping -S/W document. Agile methods, Extreme Programming, SCRUM.

UNIT 3: DESIGN CONCEPTS AND PRINCIPLES **9 Hrs.**

Design process and concepts – modular design – design heuristic – design model and document. Architectural design – software architecture – data design – architectural design – transform and transaction mapping – user interface design – user interface design principles. Real time systems - Real time software design – system design – real time executives – data acquisition system - monitoring and control system. SCM – Need for SCM – Version control – Introduction to SCM process – Software configuration items.

UNIT 4: TESTING **9 Hrs.**

Taxonomy of software testing – levels – test activities – types of s/w test – black box testing – testing boundary conditions – structural testing – test coverage criteria based on data flow mechanisms – regression testing – testing in the large. S/W testing strategies – strategic approach and issues - unit testing – integration testing – validation testing – system testing and debugging.

UNIT 5: SOFTWARE PROJECT MANAGEMENT **9 Hrs.**

Measures and measurements – S/W complexity and science measure – size measure – data and logic structure measure – information flow measure. Software cost estimation – function point models – COCOMO modelDelphi method.- Defining a Task Network – Scheduling – Earned Value Analysis – Error Tracking - Software changes – program evolution dynamics
– software maintenance – Architectural evolution. Taxonomy of CASE tools – Case Study.

ESSENTIAL READING

1. *Roger S. Pressman, Software engineering- A Practitioner's Approach, McGraw-Hill International Edition, 6th Edition 2012.*

REFERENCE READING

1. *Ian Sommerville, "Software engineering," Pearson education Asia, 9th Edition 2013.*
2. *Pankaj Jalote- "An Integrated Approach to Software Engineering," Narosa publishing house 2011.*
3. *James F Peters and Witold Pedryez, "Software Engineering – An Engineering Approach", John Wiley and Sons, New Delhi, 2010.*
4. *Ali Behforooz and Frederick J Hudson, "Software Engineering Fundamentals", OUP India 2012.*

BDS451 - LINEAR ALGEBRA USING PYTHON

Total Teaching Hours for Semester: 30
Max Marks: 50 **Credits :2**

COURSE OBJECTIVES/COURSE DESCRIPTION: This course aims at enabling the problem solving skills on the mathematical concepts of linear algebra, analytical geometry and matrix decompositions that are relevant for data science.

COURSE OUTCOMES:

1. Use Linear equations, vector spaces, linear independence and linear mappings
2. Demonstrate problem solving skills Norms, Inner products, length and distances, angles and orthogonality, orthonormal basis, orthogonal complement, inner product spaces, orthogonal spaces, orthogonal projections, rotations
3. Understand and apply Determinant and trace, eigenvalues and eigenvectors
4. Implement cholesky decomposition, eigendecomposition and singular value decomposition.

LIST OF EXERCISES FOR PRACTICAL: (USING PYTHON)

1. Vector and Matrices as arrays
2. Solving linear system of Equations
3. Arrays and operations on arrays
4. Rank of a Matrix
5. Symbolic Linear Algebra: Matrix, eigenvalue,eigenvector
6. Functions acting as Arrays:Array functions for Linear Algebra
7. Solving several linear equation systems with LU
8. Solving a least square problem with SVD

TEXT BOOKS

1. *M P Deisenroth, A A Faisal, C S Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.*
2. *H P Langtangen, C S Ong, A premier on scientific programming with Python, 5th ed., Springer, 2016.*

REFERENCE BOOKS

1. *C Hill, Learning Scientific Programming with Python, Cambridge University Press, 2016.*
2. *J M Stewart, Python for Scientists, Cambridge University Press, 2014.*
3. *A C Muller and S Guido, Introduction to Machine learning with Python -A Guide for Data Scientists, 1st ed., O'reilly, 2016.*

BDS452 - SAMPLING TECHNIQUES LAB

Total Teaching Hours/Semester: 30
Max Marks: 50 **Credits: 2**

COURSE DESCRIPTION: This course designed to introduce students about official statistical system in India and to understand basic concepts of Sampling and surveys.

COURSE OBJECTIVE: To enable the students to understand various sampling techniques and their application in various research studies.

COURSE OUTCOMES:

1. Demonstrate the official Statistical System in India.
2. Demonstrate various sampling techniques and their application
3. Infer various sampling error and non-sampling error.

LIST OF EXERCISES FOR PRACTICAL (USING EXCEL/R)

1. Random sampling using Random number tables
2. Concepts of unbiasedness, Variance, Mean square error etc.
3. Exercise on Simple Random Sampling with Replacement.
4. Exercise on Simple Random Sampling without Replacement.
5. Concepts of Simple Random Sampling for Attributes.
6. Exercise on Stratified Sampling.
7. Estimation of gain in precision due to stratification.
8. Exercise on Systematic sampling.
9. Exercise on Scaling Procedures.
10. Exercise on Cluster sampling.

BDS471 - DATA MINING

Total Teaching Hours for Semester: 90
Max Marks: 150 **Credits: 5**

COURSE OBJECTIVES: The objective of this course is to provide complete information regarding the concepts involved in data mining and knowledge discovery from databases (KDD).

COURSE OUTCOMES:

1. Understand the fundamentals of data mining.
2. Apply the concepts of KDD in real world.
3. Implement data mining algorithms for solving clustering, classification and association rule mining based applications.

UNIT 1: INTRODUCTION **6 Hrs.**

Introduction to data mining and knowledge discovery, Underlying mechanism of types of data, steps involved in KDD, Motivation, Challenges, Origin of data mining, Data mining tasks, Scope and application of data mining.

UNIT 2: DATA AND DATA PREPROCESSING **12 Hrs.**

Data: Types of Data, Attributes and Measurement, Types of Data Sets, Data Quality-Measurement and Data Collection Issues, Issues Related to Applications.

Data Preprocessing: Aggregation, Sampling, Dimensionality Reduction, Feature Subset Selection, Feature Creation, Discretization and Binarization, Variable Transformation. Measure of Similarity and dissimilarity- similarity and dissimilarity between simple attributes, similarity and dissimilarity between data objects.

UNIT 3: CLASSIFICATION AND PREDICTION **12 Hrs.**

Basic Concepts, General Framework for Classification, Types of Classifiers, Decision Tree Classifier, KNN, Bayesian, ANN, Linear Regression and SVM for both classification and prediction. Criteria for Model Selection, Model Evaluation, parameter Tuning and Model Comparison.

UNIT 4: ASSOCIATION ANALYSIS **10 Hrs.**

Introduction, Frequent Itemset Generation using Apriori algorithm, Rule Generation, Compact Representation of Frequent Itemsets, Alternative Methods for Generating Frequent Itemsets using FP growth algorithm, Evaluation of association patterns.

UNIT 5: CLUSTERING **10 Hrs.**

Introduction to Clustering, Types of clusters and clustering, Kmeans clustering, Agglomerative clustering and DBSCAN, Identification outliers, Cluster Evaluation.

UNIT 6: ADVANCED CONCEPTS IN DATA MINING **10 Hrs.**

Web, Temporal and Spatial Data Mining: Web Content Mining, Web Structure Mining, Web Usages Mining, Spatial Mining, Generalization and specialization, SpatialRules, Spatial Classification and Clustering Algorithms, Temporal Mining, Modeling Temporal Events, Times Series, Pattern Detection, Sequences.

LIST OF PROGRAMMES FOR PRACTICAL **30 Hrs.**

1. Demonstration of data transformation (Binarization, Categorization, Normalization and Standardization).
2. Demonstration of preprocessing on dataset (dimensionality reduction).
3. Demonstration of feature subset selection using mutual information.
4. Demonstration of missing value imputation.
5. Demonstration of classification process on dataset using j48 algorithm.
6. Demonstration of classification process on dataset using id3 algorithm.
7. Demonstration of classification process on dataset using naïve bayes algorithm.
8. Demonstration of prediction process on dataset using linear regression.
9. Demonstration of prediction process on dataset using ANOVA.
10. Demonstration of classification and prediction on the same dataset (Wisconsin Breast Cancer Prognostic data) using ANN
11. Demonstration of classification and prediction on the same dataset (Wisconsin Breast Cancer Prognostic data) using Support Vector Machine and Support Vector Regression respectively.
12. Demonstration of Association rule process on dataset using apriori
13. Demonstration of clustering concept on dataset using simple k-means.
14. Demonstration of Outlier identification concept on dataset using DBSCAN.
15. Demonstrate the concept of Association Rule Mining using Apriori Algorithm.

ESSENTIAL READING

1. *Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introductionto Data Mining", Pearson Education, 2nd.ed, 2016 (Reprint).*
2. *J. Han , M. Kamber and J. Pei , Data Mining: Concepts and Techniques , 3rd.ed, Morgan Kaufmann, Tata McGraw Hill, 2011.*

RECOMMENDED READING

1. *Data Mining by Vikram Pudi, P.Radha Krishna, Oxford University Press 2015.*
2. *K.P. Soman, Shyam Diwakar and V. Ajay ", Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2016.*

BDS481 - DBMS PROJECT LAB

Total Lab Hours for Semester: 75
Max Marks: 100 **Credits: 4**

COURSE OBJECTIVES: The purpose of this course is to provide comprehensive understanding to develop web applications with database systems. Started with web programming using HTML, CSS, PHP and connect with database concepts DDL, DML and PL/SQL.

COURSE OUTCOMES:

1. Understand Web Programming and DBMS components.
2. Develop dynamic web pages using HTML, PHP, CSS.
3. Develop normalized database to meet the desired needs of any web-based system.

HTML

Develop static pages using HTML
(Using Heading elements, Text Elements, Logical Styles, Physical Styles, Ordered, Unordered and Definition list, Hyper Links, Image Link, Link to page containing Images and Videos, File Link)
HTML Page using Frames.
(Navigation, Floating, Inline Frames , Frames to add Images and Videos)

CSS/ XSL /DTD

Add a Cascading Style sheet for designing the web page.
Create any catalog and display it using CSS or XSL
Document Type Definition (DTD) to validate XML
JavaScript / PHP

Design a dynamic web page with validation using JavaScript
PHP program to perform File operations / Regular Expressions
PHP program to sort the records which are stored in the database
Data Connectivity and Web Services

Install DBMS/ Configure DB Connectivity
JSF and Web Services Configurations