SCHEME & SYLLABUS OF UNDERGRADUATE DEGREE COURSE

ARTIFICIAL INTELLIGENCE & DATA SCIENCE

III & IV Semester

Effective for the students admitted in year 2020-21 and onwards.

Approved by 7th AC Meeting held on 1st Nov. 2021 (Agenda 7.5)

Dean Academics
Bikaner Technical University
Bikaner

B.Tech.: Artificial Intelligence & Data Science
2nd Year - III Semester

THEORY											
S.No.	Category	Course		Contact hrs./week			Marks				Cr
		Code	Title	L	T	P	Exam Hrs.	IA	ETE	Total	
1	BSC	3AD2-01	Probability and Statistics Theory	3	0	0	3	30	120	150	3
2	HSMC	3AD1-02/ 3AD1-03	Technical Communication/ Managerial Economics and Financial Accounting	2	0	0	2	20	80	100	2
3	ESC	3AD3-04	Digital Electronics	3	0	0	3	30	120	150	3
4	PCC	3AD4-05	Data Structures and Algorithms	3	0	0	3	30	120	150	3
5		3AD4-06	Object-Oriented Programming	3	0	0	3	30	120	150	3
6		3AD4-07	Data Science using Python	3	0	0	3	30	120	150	3
			Sub Total	**17**	**0**	**0**		**170**	**680**	**850**	**17**
PRACTICAL & SESSIONAL											
7	ESC	3AD3-21	Digital Electronics Lab	0	0	3	2	45	30	75	1.5
8	PCC	3AD4-22	Data Structures and Algorithms Lab	0	0	3	2	45	30	75	1.5
9		3AD4-23	Object-Oriented Programming Lab	0	0	3	2	45	30	75	1.5
10		3AD4-24	Python Programming Lab	0	0	3	2	45	30	75	1.5
11	PSIT	3AD7-30	Industrial Training	0	0	1		0	0	50	1
12	Anandam	3AD8-00	ANANDAM							100	2
			Sub- Total	**0**	**0**	**13**		**180**	**120**	**450**	**9**
		TOTAL OF III SEMESTER		**17**	**0**	**13**		**350**	**800**	**1300**	**26**

L: Lecture, **T**: Tutorial, **P**: Practical, **Cr**: Credits
ETE: End Term Exam, **IA:** Internal Assessment

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B.Tech.: Artificial Intelligence & Data Science
2nd Year - IV Semester

S.No.	Category	Course		Contact hrs./week			Marks				Cr
		Code	Title	L	T	P	Exam Hrs.	IA	ETE	Total	
THEORY											
1	BSC	4AD2-01	Discrete Mathematics Structure	3	0	0	3	30	120	**150**	**3**
2	HSMC	4AD103/ 4AD1-02	Technical Communication/ Managerial Economics and Financial Accounting	2	0	0	2	20	80	**100**	**2**
3	ESC	4AD3-04	Computer Architecture and Organization	3	0	0	3	30	120	**150**	**3**
4	PCC	4AD4-05	Database Management Systems	3	0	0	3	30	120	**150**	**3**
5		4AD4-06	Theory of Computation	3	0	0	3	30	120	**150**	**3**
6		4AD4-07	Data Handling and Visualization	3	0	0	3	30	120	**150**	**3**
			Sub Total	**17**	**0**	**0**		**170**	**680**	**850**	**17**
PRACTICAL & SESSIONAL											
7	PCC	4AD4-21	Database Management System Lab	0	0	3	2	45	30	**75**	**1.5**
8		4AD4-22	R Programming Lab	0	0	3	2	45	30	**75**	**1.5**
9		4AD4-23	Data Handling and Visualization Lab	0	0	3	2	45	30	**75**	**1.5**
10		4AD4-24	Java Programming	0	0	3	2	45	30	**75**	**1.5**
11	Anandam	4AD8-00	ANANDAM							**100**	**2**
			Sub- Total	**0**	**0**	**12**		**180**	**120**	**400**	**8**
		TOTAL OF IV SEMESTER		**17**	**0**	**12**		**350**	**800**	**1250**	**25**

L: Lecture, **T**: Tutorial, **P**: Practical, **Cr**: Credits
ETE: End Term Exam, **IA:** Internal Assessment

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SYLLABUS OF
UNDERGRADUATE DEGREE COURSE

ARTIFICIAL INTELLIGENCE & DATA SCIENCE

III & IV Semester

Effective for the students admitted in year 2020-21 and onwards.

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3AD2-01: Probability and Statistics Theory

Credit: 3	Max Marks: 150 (IA :30, ETE:120)
3L+ 0T+ 0P	End Term Exams: 3hr

S.No.	Contents	Hours
1	**PROBABILITY:** Introduction to Probability: Definitions, scope, and history; limitation of classical and relative-frequency-based definitions. Applications of Sets, fields, sample space, and events; axiomatic definition of probability. Joint and conditional probabilities, independence, total probability; Bayes' rule and applications. Combinatorics: Probability on finite sample spaces.	8
2	**PROBABILITY DISTRIBUTIONS:** Random variables, Probability Distribution, Mathematical Expectation and Variance of a Probability distribution, Standard discrete distributions: Binomial, Poisson and Geometric distributions, Probability density function, Cumulative distribution function, Expectation and Variance, Standard continuous distributions – Uniform, Normal, Exponential, Joint distribution, and Joint density functions.	8
3	**SAMPLING THEORY:** Population and Sample, Statistical inference, Sampling with and without replacement, Random samples, Population parameters, Sample statics, Sampling distributions, Sample mean, Sampling distribution of means, Sample variances, Sampling distribution of variances, Case where population variances is unknown, Unbiased estimates and efficient estimates, the point estimate and Interval Estimates, Confidence Interval estimates of population parameters, Confidence intervals for the variance of a Normal distribution, Maximum likelihood estimates.	8
4	**TEST OF HYPOTHESIS AND SIGNIFICANCE** Statistical hypothesis, Null and Alternate hypothesis, the test of hypothesis and significance, Type I and Type II errors, Level of Significance, Tests involving the Normal distribution, One-Tailed and Two-Tailed tests, P-value. Special tests of significance for large samples and small samples (F, chi-square, z, t-test), ANOVA.	7
5	**CORRELATION AND REGRESSION:** Correlation, Rank correlation, Regression Analysis, Linear and Non-linear Regression, Multiple regression, Curve fitting by meth-od of least squares, fitting of straight lines, polynomials, exponential curves.	8
	TOTAL	39

Suggested Books

- Probability, Statistics & Random Process T. Veerajan TMH
- Fundamentals of Mathematical Statistics S.C Gupta & V. K Kapoor, S. Chand
- E. Walpole, R. H. Mayers, S. L. Mayers, and K. Ye, (2007), Probability and Statistics for Engineers and Scientists,8th Edition, Pearson Education, ISBN: 978-8-131-71552-9.
- Sheldon M. Ross, (2011), Introduction to Probability and Statistics for Engineers and Scientists, 4th Edition, Academic Foundation, ISBN: 978-8-190-93568-5.
- Ibe. O. C., Fundamentals of Applied Probability and Random Processes (2 ed.), Elsevier, 2014. ISBN 978-0128008522
- Douglas C. Montgomery, (2012), Applied Statistics and Probability for Engineers, 5th Edition, Wiley India, ISBN: 978-8-126-53719-8.
- Spiegel, M. R., Schiller, J., and Srinivasan, R. A., (2010), Probability & Statistics, 3rdEdition, Tata McGraw Hill, ISBN: 978-0-070-15154-3.
- Statistics & Probability Theory Schaum's TMH

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3AD1-02: Technical Communication

Credit: 2		Max Marks: 100 (IA :20, ETE:80)
2L+ 0T+ 0P		End Term Exams: 2hr
S.No.	**Contents**	**Hours**
1	**Introduction to Technical Communication- Definition** of technical communication, Aspects of technical communication, forms of technical communication, the importance of technical communication, technical communication skills (Listening, speaking, writing, reading writing), linguistic ability, style in technical communication.	4
2	**Comprehension of Technical Materials/Texts and Information Design & development-** Reading of Technical texts, Reading and comprehending instructions and technical manuals, Interpreting and summarizing technical texts, Note-making. Introduction of different kinds of technical documents, Information collection, factors affecting information and document design, Strategies for organization, Information design, and writing for print and online media.	6
3	**Technical Writing, Grammar and Editing-** Technical writing process, forms of technical discourse, Writing, drafts and revising, Basics of grammar, common error in writing and speaking, Study of advanced grammar, Editing strategies to achieve appropriate technical style, Introduction to advanced technical communication. Planning, drafting and writing Official Notes, Letters, E-mail, Resume, Job Applications, and Minutes of Meetings.	8
4	**Advanced Technical Writing-** Technical Reports, types of technical reports, Characteristics and formats, and structure of technical reports. Technical Project Proposals, types of technical proposals, Characteristics and formats and structure of technical proposals. Technical Articles, types of technical articles, Writing strategies, structure and formats of technical articles.	8
	TOTAL	26

Suggested Books

- Effective Technical Communication M Ashraf Rizvi McGraw Hill Education (India) Private limited
- Technical Communication A Practical Approach William Sanborn Pfeiffer Pearson Education India

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3AD1-03: Managerial Economics and Financial Accounting

Credit: 2		Max Marks: 100 (IA :20, ETE:80)
2L+ 0T+ 0P		End Term Exams: 2hr
S.No.	**Contents**	**Hours**
1	**Basic Economics Concepts:** Meaning, nature and scope of economics deductive vs inductive methods, static and dynamics, Economic problems: scarcity and choice, circular flow of economic activity, national income-concepts and measurement.	4
2	**Demand and Supply analysis- Demand**-types of demand, determinants of demand, demand function, elasticity of demand, demand forecasting –purpose, determinants and methods, Supply- determinants of supply, supply function, elasticity of supply.	5
3	**Production and Cost analysis-** Theory of production- production function, law of variable proportions, laws of returns to scale, production optimization, a least-cost combination of inputs, isoquants. Cost concepts-explicit and implicit cost, fixed and variable cost, opportunity cost, sunk costs, cost function, cost curves, cost and output decisions, cost estimation.	5
4	**Market structure and pricing theory-** Perfect competition, Monopoly, Monopolistic competition, Oligopoly.	4
5	**Financial statement analysis-** Balance sheet and related concepts, profit and loss statement and related concepts, financial ratio analysis, cash-flow analysis, funds- flow analysis, comparative financial statement, analysis and interpretation of financial statements, capital budgeting techniques.	8
TOTAL		**26**

Suggested Books

- M. Kasi Reddy and S. Saraswati, Managerial Economics and Financial Accounting, Prentice Hall India Learning Private Limited, 2007.
- P, Vijaya Kumar and N. Appa Rao, Managerial Economics & Financial Analysis, Cengage, 1st edition, 2011
- SA Siddiqui and AS Siddiqui, Managerial Economics and Financial Analysis, New Age International (P) Ltd Publishers, 2nd Edition, 2017
- A R Aryasri, Managerial Economics and Financial Analysis, by, The McGraw-Hill Publishing Company Limited, Delhi, Third Edition, 2007
- M S Bhat and A V Rau, Managerial Economics and Financial Analysis, BS Publications, 2016

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3AD3-04: Digital Electronics

Credit: 3		Max Marks: 150 (IA :30, ETE:120)
3L+ 0T+ 0P		End Term Exams: 3hr
S.No.	**Contents**	**Hours**
1	**Fundamental concepts:** Number systems and codes, Basic logic Gates and Boolean algebra: Sign & magnitude representation, Fixed point representation, complement notation, various codes & arithmetic in different codes & their interconversion. Features of logic algebra, postulates of Boolean algebra. Theorems of Boolean algebra.	8
2	**Minimization Techniques and Logic Gates:** Principle of Duality - Boolean expression - Minimization of Boolean expressions — Minterm – Maxterm - Sum of Products (SOP) – Product of Sums (POS) – Karnaugh map Minimization – Don't care conditions– Quine - McCluskey method of minimization.	8
3	**Digital Logic Gate Characteristics:** logic gate characteristics. Theory & operation of TTL NAND gate circuitry. Open collector TTL. Three state output logic.T TL subfamilies. MOS & CMOS logic families. Realization of logic gates in RTL, DTL, ECL, C-MOS & MOSFET.	8
4	**Combinational Circuits:** Combinational logic circuit design, adder, subtractor, BCD adder encoder, decoder, BCD to7-segment decoder, multiplexer demultiplexer.	8
5	**Sequential Circuits:** Latches, Flip-flops - SR, JK, D, T, and Master-Slave Characteristic table and equation, counters and their design, Synchronous counters – Synchronous Up/Down counters – Programmable counters – State table and state transition diagram, sequential circuits design methodology. Registers –shift registers.	8
	TOTAL	40

Suggested Books

- Digital integrated electronics, By Herbert Taub, Donald L. Shilling, TMH
- Digital Logic and Computer Design By M. Morris Mano, Pearson
- Modern Digital Electronics By R.P. Jain, TMH
- Fundamentals of Digital Circuits By A. Anand Kumar, PHI
- Digital circuit design By S. Salivahanan, Sarivazhagan, Vikas publications

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3AD4-05: Data Structures and Algorithms

Credit: 3	Max Marks: 150 (IA :30, ETE:120)
3L+ 0T+ 0P	End Term Exams: 3hr

S.No.	Contents	Hours
1	**Stacks:** Basic Stack Operations, Representation of a Stack using Static Array and Dynamic Array, Multiple stack implementation using a single array, Stack Applications: Reversing list, Factorial Calculation, Infix to postfix Transformation, Evaluating Arithmetic Expressions and Towers of Hanoi.	8
2	**Queues**: Basic Queue Operations, Representation of a Queue using the array, Implementation of Queue Operations using Stack, Applications of Queues- Round Robin Algorithm. Circular Queues, Dequeue Priority Queues. Linked Lists: Introduction, singly linked list, representation of a linked list in memory, Different Operations on a Single linked list, reversing a single linked list, Advantages and disadvantages of single linked list, circular linked list, double linked list, and Header linked list.	8
3	**Searching Techniques**: Sequential and binary search. Sorting Techniques: Basic concepts, sorting by bubble sort, Insertion sort, selection sort, quick sort, heap sort, merge sort, radix sort, and counting sorting algorithms.	8
4	**Trees:** Definition of the tree, Properties of the tree, Binary Tree, Representation of Binary trees using arrays and linked lists, Operations on a Binary Tree, Binary Tree Traversals (recursive), Binary search tree, B-tree, B+ tree, AVL tree, Threaded binary tree.	8
5	**Graphs:** Basic concepts, Different representations of Graphs, Graph Traversals (BFS & DFS), Minimum Spanning Tree (Prims &Kruskal), Dijkstra's shortest path algorithms. Hashing: Hash function, Address calculation techniques, and Common hashing functions, Collision resolution: Linear and Quadratic probing, Double hashing.	8
	TOTAL	40

Suggested Books

- An Introduction to data structures with applications By Jean-Paul Tremblay, P. G. Sorenson, TMH
- Data Structures in C/C++, Tanenbaum, Pearson
- Data Structures and Algorithms, Aho and Ullman
- Simplified Approach to Data Structures", Shroff Publications and Distributors Lalit Goyal, Vishal Goyal, Pawan Kumar, "
- Data Structures – Horowitz Sahni PHI
- Data Structures – Lipschitz TMH

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3AD4-06: Object-Oriented Programming

Credit: 3	Max Marks: 150 (IA :30, ETE:120)
3L+ 0T+ 0P	End Term Exams: 3hr

S.No.	Contents	Hours
1	Introduction to different programming paradigm, characteristics of OOP, Class, Object, data member, member function, structures in C++, different access specifiers, defining member function inside and outside class, an array of objects.	8
2	Concept of reference, dynamic memory allocation using new and delete operators, inline functions, function overloading, function with default arguments, constructors and destructors, friend function and classes, using this pointer.	8
3	Inheritance, types of inheritance, multiple inheritances, virtual base class, function overriding, abstract class, and pure virtual function.	9
4	Constant data member and member function, static data member and member function, Polymorphism, operator overloading, dynamic binding, and virtual function	9
5	Exception handling, Template, Stream class, File handling.	6
	TOTAL	40

Suggested Books

- Balagurusamy E., "Object-oriented programming with C++," Fifth Edition, Third Reprint, Tata McGraw–Hill Education 2011.
- Ira Pohl, "Object-Oriented Programming using C++," Pearson Education, Second Edition, Reprint 2004.
- Lippman S. B., Josee Lajoie, Barbara E. Moo, "C++ Primer", Fourth Edition, Pearson Education, 2005.

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3AD4-07: Data Science using Python

Credit: 3		Max Marks: 150 (IA :30, ETE:120)
3L+ 0T+ 0P		End Term Exams: 3hr
S.No.	**Contents**	**Hours**
1	**Introduction to Data Science** - Why Python? - Essential Python libraries - Python Introduction- Features, Identifiers, Reserved words, Indentation, Comments, Built-in Data types, and their Methods: Strings, List, Tuples, Dictionary, Set - Type Conversion- Operators. Decision Making- Looping- Loop Control statement- Math and Random number functions. User-defined functions - function arguments & its types.	8
2	**Toolboxes:** Python, fundamental libraries for Data Scientists. Integrated development environment (IDE). User-defined Modules and Packages in Python- Files: File manipulations, File and Directory related - Python Exception Handling. OOPs Concepts -Class and Objects, Constructors – Data hiding- Data Abstraction- Inheritance.	8
3	**NumPy Basics:** Arrays and Vectorized Computation- The NumPy ND array- Creating ND arrays- Data Types for ND arrays- Arithmetic with NumPy Arrays- Basic Indexing and Slicing - Boolean Indexing-Transposing Arrays and Swapping Axes. Universal Functions: Fast Element-Wise Array Functions- Mathematical and Statistical Methods- Sorting Unique and Other Set Logic.	8
4	**Introduction to pandas Data Structures:** Series, Data Frame, Essential Functionality: Dropping Entries Indexing, Selection, and Filtering- Function Application and Mapping- Sorting and Ranking. Summarizing and Computing Descriptive Statistics- Unique Values, Value Counts, and Membership. Reading and Writing Data in Text Format.	8
5	**Data Cleaning and Preparation:** Handling Missing Data - Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers- String Manipulation: Vectorized String Functions in pandas. Plotting with pandas: Line Plots, Bar Plots, Histograms, and Density Plots, Scatter or Point Plots.	8
	Total	40

Suggested Books

- Introduction to Data Science a Python approach to concepts, Techniques and Applications, Igual, L;Seghi', S. Springer, ISBN:978-3-319-50016-4
- Data Analysis with Python A Modern Approach, David Taieb, Packt Publishing, ISBN-9781789950069
- Y. Daniel Liang, "Introduction to Programming using Python", Pearson,2012.
- Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly, 2nd Edition,2018.
- Jake VanderPlas, "Python Data Science Handbook: Essential Tools for Working with Data", O'Reilly, 2017
- Wesley J. Chun, "Core Python Programming", Prentice Hall,2006.
- Mark Lutz, "Learning Python", O'Reilly, 4th Edition, 2009.

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3AD3-21: Digital Electronics Lab

Credit: 1.5	Max Marks: 75 (IA :45, ETE:30)
0L+ 0T+ 3P	End Term Exams: 2hr

S.No.	List of Experiments
1	To verify the truth tables of basic logic gates: AND, OR, NOR, NAND, NOR. Also, to verify truth table of Ex-OR, Ex-NOR (For 2, 3, & 4 inputs using gates with 2, 3, & 4 inputs).
2	To verify the truth table of OR, AND, NOR, Ex-OR, Ex-NOR realized using NAND& NOR gates.
3	To realize an SOP and POS expression.
4	To realize Half adder/ Subtractor & Full Adder/ Subtractor using NAND & NOR gates and to verify their truth tables.
5	To realize a 4-bit ripple adder/ Subtractor using basic Half adder/ Subtractor & basic Full Adder/ Subtractor
6	To verify the truth table of the 4-to-1 multiplexer and 1-to-4 demultiplexer. Realize the multiplexer using basic gates only. Also, to construct an 8-to-1 multiplexer and 1-to-8 demultiplexer using blocks of the 4-to-1 multiplexer and 1-to-4 demultiplexer.
7	Design & realize a combinational circuit that will accept a 2421 BCD ode and drive a TIL -312 seven-segment display.
8	Using basic logic gates, realize the R-S, J-K, and D- flip flops with and without clock signal and verify their truth table.
9	Construct a divide by 2, 4 & 8 asynchronous counter. Construct a 4-bit binary counter and ring counter for a particular output pattern using D flip flop.
10	Perform input/output operations on parallel in/Parallel out and Serial in/Serial out registers using lo k. Also, exercise loading only one of the multiple values into the register using a multiplexer. Note: As far as possible, the experiments shall be performed on breadboard. However, experiment Nos. 1-4 are to be performed on breadboard only

Suggested Books

- Digital integrated electronics, By Herbert Taub, Donald L. Shilling, TMH
- Digital Logic and Computer Design by M. Morris Mano, Pearson
- Modern Digital Electronics by R.P. Jain, TMH
- Fundamentals of Digital Circuits by A. Anand Kumar, PHI
- Digital circuit design By S. Salivahanan, Sarivazhagan, Vikas publications

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3AD4-22: Data Structures and Algorithms Lab

Credit: 1.5	Max Marks: 75 (IA :45, ETE:30)
0L+ 0T+ 3P	End Term Exams: 2hr

S.No.	List of Experiments
1	Write a simple C program on a 32-bit compiler to understand the concept of array storage and word size. The program shall be written illustrating the concept of row-major and column-major storage. Find the address of the element and verify it with the theoretical value. The program may be written for arrays up to 4-dimensions.
2	Simulate a stack, queue, circular queue, and de queue using a one-dimensional array as a storage element. The program should implement the basic addition, deletion and traversal operations.
3	Represent a 2-variable polynomial using an array. Use this representation to implement the addition of polynomials
4	Represent a sparse matrix using an array. Implement addition and transposition operations using the representation.
5	Implement singly, doubly, and circularly connected linked lists illustrating operations like addition at different locations, deletion from specified locations, and traversal.
6	Repeat exercises 2, 3 & 4 with linked structure.
7	Implementation of a binary tree with operations like addition, deletion, traversal.
8	Depth-first and breadth-first traversal of graphs represented using adjacency matrix and list.
9	Implementation of binary search in arrays and on linked Binary Search Tree.
10	Implement different sorting algorithms like insertion, quick, heap, bubble, and many more sorting algorithms.

Suggested Books

- An Introduction to data structures with applications By Jean-Paul Tremblay, P. G. Sorenson, TMH
- Data Structures in C/C++, Tanenbaum, Pearson
- Data Structures and Algorithms, Aho and Ullman
- Simplified Approach to Data Structures", Shroff Publications and Distributors Lalit Goyal, Vishal Goyal, Pawan Kumar, "
- Data Structures – Horowitz Sahni PHI
- Data Structures – Lipschutz TMH

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3AD4-23: Object-Oriented Programming Lab

Credit: 1.5		Max Marks: 75 (IA :45, ETE:30)
0L+ 0T+ 3P		End Term Exams: 2hr
S.No.	**List of Experiments**	
1	Understand the basics of the C++ library, variables, data input-output.	
2	C++ program using the concept of structures.	
3	Implement class and object concepts and function overloading.	
4	Write programs to understand dynamic memory allocation and an array of objects.	
5	Program to understand different types of constructors and destructors.	
6	Implement the friend function to access private data of a class and usage of this pointer.	
7	Write programs to understand the usage of constant data member and member function, static data member and member function in a class.	
8	Implement different types of inheritance, function overriding, and virtual Function	
9	Implement Operator overloading concepts.	
10	Write programs to understand function templates and class templates.	
11	Write programs to understand exception handling techniques.	
12	Write programs to understand file handling techniques.	

Suggested Books

- Balagurusamy E., "Object-oriented programming with C++," Fifth Edition, Third Reprint, Tata McGraw–Hill Education 2011.
- Ira Pohl, "Object-Oriented Programming using C++," Pearson Education, Second Edition, Reprint 2004.
- Lippman S. B., Josee Lajoie, Barbara E. Moo, "C++ Primer", Fourth Edition, Pearson Education, 2005.

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3AD4-24: Python Programming Lab

Credit: 1.5	Max Marks: 75 (IA :45, ETE:30)
0L+ 0T+ 3P	End Term Exams: 2hr

S.No.	List of Experiments
1.	Implement basic Python programs for reading input from the console
2.	Perform Creation, indexing, slicing, concatenation, and repetition operations on Python built-in data types: Strings, List, Tuples, Dictionary, Set
3.	Solve problems using decision and looping statements
4.	Apply Python built-in data types: Strings, List, Tuples, Dictionary, Set and their methods to solve any given problem.
5.	Handle numerical operations using math and random number functions
6.	Create user-defined functions with different types of function arguments.
7.	Perform File manipulations- open, close, read, write, append and copy from one file to another.
8.	Handle Exceptions using Python Built-in Exceptions
9.	Solve problems using Class declaration and Object creation and Implement OOP concepts like Data hiding and Data Abstraction.
10.	Intrinsic NumPy objects and Random Functions. Manipulation of NumPy arrays- Indexing, Slicing, Reshaping, Joining, and Splitting
11.	Computation on NumPy arrays using Universal Functions and Mathematical methods.
12.	Import a CSV file and perform various Statistical and Comparison operations on rows/columns.
13.	Manipulation of NumPy arrays- Indexing, Slicing, Reshaping, Joining, and Splitting.
14	Import a CSV file and perform various Statistical and Comparison operations on rows/columns.
15	Import any CSV file to Pandas DataFrame and perform the following: (a) Handle missing data by detecting and dropping/ filling missing values. (b) Transform data using apply() and map() method. (c) Detect and filter outliers. (d) Perform Vectorized String operations on Pandas Series. (e) Visualize data using Line Plots, Bar Plots, Histograms, Density Plots and Scatter Plots

Suggested Books

- Beginning Python Wrox Publication Peter Norton, Alex Samuel
- Starting Out with Python (2009) Pearson, Tonny Gaddis
- Y. Daniel Liang, "Introduction to Programming using Python," Pearson,2012.
- Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython," O'Reilly, 2nd Edition,2018.
- Jake VanderPlas, "Python Data Science Handbook: Essential Tools for Working with Data," O'Reilly, 2017.

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4AD2-01: Discrete Mathematics Structure

Credit: 3	Max Marks: 150 (IA :30, ETE:120)
3L+ 0T+ 0P	End Term Exams: 3hr

S.No.	Contents	Hours
1	**Introduction:** Objective, scope, and outcome of the course.	1
2	**Set Theory:** Definition of sets, countable and uncountable sets, Set operations, Partition of the set, Cardinality (Inclusion-Exclusion & Addition Principles), Venn Diagrams, proofs of some general identities on sets. **Relation:** Definition, Types of relation, the composition of relations, Pictorial representation of the relation, Equivalence relation, Partial ordering relation, Job-Scheduling problem. **Function:** Definition, type of functions, one to one, into and onto function, inverse function, the composition of functions, recursively defined functions, pigeonhole principle. Theorem proving Techniques: Mathematical induction, Proof by contradiction. Composition of Functions. The Pigeonhole and Generalized Pigeonhole Principles.	7
3	**Propositional Logic:** Proposition, First-order logic, Basic logical operation, truth tables, tautologies, Contradictions, Algebra of Proposition, logical implications, logical equivalence, predicates, Normal Forms, Universal and existential quantifiers. 2-way predicate logic. Introduction to finite state machine Finite state machines as models of physical system equivalence machines, Finite state machines as language recognizers.	8
4	**Posets, Hasse Diagram, and Lattices:** Introduction, ordered set, Hasse diagram of partially, ordered set, isomorphic ordered set, well ordered set, properties of Lattices, bounded and complemented lattices. Combinatorics: Introduction, Permutation and Combination, Binomial Theorem, Multimodal Coefficients Recurrence Relation, and Generating Function: Introduction to Recurrence Relation and Recursive algorithms, linear recurrence relations with constant coefficients, Homogeneous solutions, Particular solutions, Total solutions, generating functions, Solution by the method of generating functions.	8
5	**Algebraic Structures:** Definition, Properties, types: Semi Groups, Monoid, Groups, Abelian group, properties of groups, Subgroup, cyclic groups, Cosets, factor group, Permutation groups, Normal subgroup, Homomorphism and isomorphism of Groups, example and standard results, Rings and Fields: definition and standard results.	8
6	**Graph Theory:** Introduction and basic terminology of graphs, Planer graphs, Multigraphs, and weighted graphs, Isomorphic graphs, Paths, Cycles and connectivity, shortest path in a weighted graph, Introduction to Eulerian paths and circuits, Hamiltonian paths and circuits, Graph coloring, chromatic number, Isomorphism and Homomorphism of graphs, matching, vertex/edge covering.	8
	Total	40

Suggested Books

- Singaravelu, M. P. Jeyaraman, "Discrete Mathematics," Meenakshi Agency, 2013.
- Kenneth H. Roshan, "Discrete Mathematics and its Applications," Tata McGraw Hill, 2011.
- Trembly J.P and Monohar R, "Discrete Mathematical Structures with Applications to Computer Science," Tata McGraw Hill, 2003.
- Trivedi. K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications," John Wiley and Sons, 2nd Edition, 2002.
- J. A. Bondy and U.S.R Murty, "Graph Theory", Springer, 2008.

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4AD1-02: Technical Communication

Credit: 2	Max Marks: 100 (IA :20, ETE:80)
2L+ 0T+ 0P	End Term Exams: 2hr

S.No.	Contents	Hours
1	**Introduction to Technical Communication- Definition** of technical communication, Aspects of technical communication, forms of technical communication, the importance of technical communication, technical communication skills (Listening, speaking, writing, reading writing), linguistic ability, style in technical communication.	4
2	**Comprehension of Technical Materials/Texts and Information Design & development-** Reading of Technical texts, Reading and comprehending instructions and technical manuals, Interpreting, and summarizing technical texts, Note-making. Introduction of different kinds of technical documents, Information collection, factors affecting information and document design, Strategies for organization, Information design, and writing for print and online media.	6
3	**Technical Writing, Grammar and Editing-** Technical writing process, forms of technical discourse, Writing, drafts and revising, Basics of grammar, common error in writing and speaking, Study of advanced grammar, editing strategies to achieve appropriate technical style, Introduction to advanced technical communication. Planning, drafting, and writing Official Notes, Letters, E-mail, Resume, Job Applications, and Minutes of Meetings.	8
4	**Advanced Technical Writing-** Technical Reports, types of technical reports, Characteristics and formats, and structure of technical reports. Technical Project Proposals, types of technical proposals, Characteristics and formats, and structure of technical proposals. Technical Articles, types of technical articles, Writing strategies, structure and formats of technical articles.	8
	TOTAL	26

Suggested Books

- Effective Technical Communication M Ashraf Rizvi McGraw Hill Education (India) Private limited
- Technical Communication A Practical Approach William Sanborn Pfeiffer Pearson Education India

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4AD1-03: Managerial Economics and Financial Accounting

Credit: 2		Max Marks: 100 (IA :20, ETE:80)
2L+ 0T+ 0P		End Term Exams: 2hr
S.No.	**Contents**	**Hours**
1	**Basic Economics Concepts:** Meaning, nature and scope of economics deductive vs inductive methods, static and dynamics, Economic problems: scarcity and choice, circular flow of economic activity, national income-concepts and measurement	4
2	**Demand and Supply analysis- Demand**-types of demand, determinants of demand, demand function, elasticity of demand, demand forecasting –purpose, determinants and methods, Supply- determinants of supply, supply function, elasticity of supply.	5
3	**Production and Cost analysis-** Theory of production- production function, law of variable proportions, laws of returns to scale, production optimization, a least-cost combination of inputs, isoquants. Cost concepts-explicit and implicit cost, fixed and variable cost, opportunity cost, sunk costs, cost function, cost curves, cost and output decisions, cost estimation.	5
4	**Market structure and pricing theory-** Perfect competition, Monopoly, Monopolistic competition, Oligopoly.	4
5	**Financial statement analysis-** Balance sheet and related concepts, profit and loss statement and related concepts, financial ratio analysis, cash-flow analysis, funds- flow analysis, comparative financial statement, analysis and interpretation of financial statements, capital budgeting techniques.	8
TOTAL		**26**

Suggested Books

- M. KAsi Reddy and S. Saraswati, Managerial Economics and Financial Accounting, Prentice Hall India Learning Private Limited, 2007.
- P, Vijaya Kumar and N. Appa Rao, Managerial Economics & Financial Analysis, Cengage, 1st edition, 2011
- SA Siddiqui and AS Siddiqui, Managerial Economics and Financial Analysis, New Age International (P) Ltd Publishers, 2nd Edition, 2017
- A R Aryasri, Managerial Economics and Financial Analysis, by, The McGraw-Hill Publishing Company Limited, Delhi, Third Edition, 2007
- M S Bhat and A V Rau, Managerial Economics and Financial Analysis, BS Publications, 2016

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4AD3-04: Computer Architecture and Organization

Credit: 3	Max Marks: 150 (IA :30, ETE:120)
3L+ 0T+ 0P	End Term Exams: 3hr

S.No.	Contents	Hours
1	**Introduction:** Objective, scope, and outcome of the course.	01
2	**Computer Data Representation:** Basic computer data types, Complements, Fixed point representation, Register Transfer and Micro-operations: Floating-point representation, Register Transfer language, Register Transfer, Bus and Memory Transfers (Tree-State Bus Buffers, Memory Transfer), Arithmetic Micro-Operations, Logic Micro-Operations, Shift micro-operations, Arithmetic logical shift unit. Basic Computer Organization and Design Instruction codes, Computer registers, computer instructions, Timing and Control, Instruction cycle, Memory-Reference Instructions, Input-output and interrupt, Complete computer description, Design of Basic computer, design of Accumulator Unit.	10
3	**Programming The Basic Computer: Introduction**, Machine Language, Assembly Language, assembler, Program loops, Programming Arithmetic and logic operations, subroutines, I-O Programming. Micro programmed Control: Control Memory, Address sequencing, Micro program Example, design of control Unit.	7
4	**Central Processing Unit:** Introduction, General Register Organization, Stack Organization, Instruction format, Addressing Modes, data transfer and manipulation, Program Control, Reduced Instruction Set Computer (RISC)Pipeline and Vector Processing, Flynn's taxonomy, Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction, Pipeline, RISC Pipeline, Vector Processing, Array Processors	8
5	**Computer Arithmetic:** Introduction, Addition, and subtraction, Multiplication Algorithms (Booth Multiplication Algorithm), Division Algorithms, Floating Point Arithmetic operations, Decimal Arithmetic Unit. Input-Output Organization Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, DMA, Input-Output Processor (IOP), CPUIOP Communication, Serial Communication.	8
6	**Memory Organization:** Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory. Multiprocessors: Characteristics of Multiprocessors, Interconnection Structures, Inter-processor Arbitration, Inter-processor Communication and Synchronization, Cache Coherence, Shared Memory Multiprocessors.	8
	Total	42

Suggested Books

- William stallings, "Computer Organization and Architectue, PHI" 2. M. Morris Mano,
- M. Morris Mano, "Computer System Architecture" , PHI
- J.D. Carpinelli, "Computer Systems Organization and Architecture," Pearson Education
- Heuring and Jordan, Pearson Education, "Computer Systems Design and Architecture"

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4AD4-05: Database Management Systems

Credit: 3	Max Marks: 150 (IA :30, ETE:120)
3L+ 0T+ 0P	End Term Exams: 3hr

S.No.	Contents	Hours
1	**Introduction:** Objective, scope, and outcome of the course.	1
2	**Introduction to database systems:** Overview and History of DBMS. File System v/s DBMS. Advantages of DBMS Describing and Storing Data in a Masquerades in DBMS. Structure of a DBMS. Entity-Relationship model: Overview of Data Design Entities, Attributes and Entity Sets, Relationship and Relationship Sets. Features of the ER Model- Key Constraints, Participation Constraints, Weak Entities, Class Hierarchies, Aggregation, Conceptual Data Base, and Design with ER Model- Entity v/s Attribute, Entity vs. Relationship Binary vs. Ternary Relationships and Aggregation v/s ternary Relationship Conceptual Design for a Large Enterprise.	7
3	**Relationship Algebra and Calculus:** Relationship Algebra Selection and Projection, Set Operations, Renaming, Joints, Division, Relation Calculus, Expressive Power of Algebra and Calculus. **SQL queries programming and Triggers:** The Forms of a Basic SQL Query, Union, and Intersection and Except, Nested Queries, Correlated Nested Queries, Set-Comparison Operations, Aggregate Operators, Null Values and Embedded SQL, Dynamic SQL, ODBC and JDBC, Triggers and Active Databases.	8
4	**Schema Refinement and Normal forms**: Introductions to Schema Refinement, Functional Dependencies, Boyce-Codd Normal Forms, Third Normal Form, Normalization-Decomposition into BCNF Decomposition into 3-NF.	8
5	**Transaction Processing:** Introduction-Transaction State, Transaction properties, Concurrent Executions. Need of Serializability, Conflict vs. View Serializability, Testing for Serializability, Recoverable Schedules, Cascade less Schedules.	8
6	**Concurrency-Control:** Implementation of Concurrency: Lock-based protocols, Timestamp-based protocols, Validation-based protocols, Deadlock handling, Database Failure, and Recovery: Database Failures, Recovery Schemes: Shadow Paging and Log-based Recovery, Recovery with Concurrent transactions.	8
	Total	40

Suggested Books

- Abraham Silberschatz, Henry F. Korth, and S. Sudarshan- —Database System Concepts, Sixth Edition, McGraw-Hill, 2011.
- Ramez Elmasri and Shamkant B. Navathe, —Fundamental Database Systemsl, Seventh Edition, Pearson Education,2016.
- Raghu Ramakrishnan, —Database Management System, Tata McGraw-Hill Publishing Company, Third Edition, 2014.
- Jiawei Han, Micheline Kamber, Jian Pei -Data Mining Concepts and Techniques, Morgan Kaufmann, Third Edition, 2012

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4AD4-06: Theory of Computation

Credit: 3	Max Marks: 150 (IA :30, ETE:120)
3L+ 0T+ 0P	End Term Exams: 3hr

S.No.	Contents	Hours
1	**Finite Automata & Regular Expression:** Basic machine, Finite state machine, Transition graph, Transition matrix, Deterministic and non-deterministic finite automation, Equivalence of DFA and NDFA, Decision properties, minimization of finite automata, Mealy & Moore machines. Alphabet, words, Operations, Regular sets, relationship and conversion between Finite automata and a regular expression and vice versa, designing regular expressions, closure properties of regular sets, Pumping lemma and regular sets, Myhill- Nerode theorem, Application of pumping lemma, Power of the languages.	8
2	**Context-Free Grammars (CFG),** Derivations and Languages, Relationship between derivation and derivation trees, leftmost and rightmost derivation, sentential forms, parsing and ambiguity, simplification of CFG, normal forms, Greibach and Chomsky Normal form, Problems related to CNF and GNF including membership problem.	8
3	**Nondeterministic PDA, Definitions,** PDA and CFL, CFG for PDA, Deterministic PDA, and Deterministic PDA and Deterministic CFL, The pumping lemma for CFL's, Closure Properties and Decision properties for CFL, Deciding properties of CFL.	8
4	**Turing Machines:** Introduction, Definition of Turing Machine, TM as language Acceptors and Transducers, Computable Languages and functions, Universal TM & Other modification, multiple tracks Turing Machine. Hierarchy of Formal languages: Recursive & recursively enumerable languages, Properties of RL and REL, Introduction of Context-sensitive grammars and languages, The Chomsky Hierarchy.	8
5	**Tractable and Untractable Problems:** P, NP, NP-complete and NP-hard problems, Un-decidability, examples of these problems like vertex cover problem, Hamiltonian path problem, traveling salesman problem.	8
	Total	40

Suggested Books

- Hopcroft J.E., Motwani R., and Ullman J.D, "Introduction to Automata Theory, Languages and Computations," Second Edition, Pearson Education.
- John C Martin, "Introduction to Languages and the Theory of Computation", Third Edition, Tata McGraw Hill Publishing Company, New Delhi
- Marvin L. Minsky "Computation: Finite and Infinite" – Prentice Hall, 1967
- Michael Sipser "Introduction to the Theory of Computation" , Third Edition, 2012 Cengage Learning
- Peter Lenz – An Introduction to Formal languages and Automata – 3rd Edition Narosa, 2003
- Thomas A. Sukamp – An introduction to the theory of computer science languages and machines – 3rd edition, Pearson Education, 2007.

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4AD4-07: Data Handling and Visualization

Credit: 3	Max Marks: 150 (IA :30, ETE:120)
3L+ 0T+ 0P	End Term Exams: 3hr

S.No.	Contents	Hours
1	Visualizing Data-Mapping Data onto Aesthetics, Aesthetics and Types of Data, Scales Map Data Values onto Aesthetics, Coordinate Systems and Axes- Cartesian Coordinates, Nonlinear Axes, Coordinate Systems with Curved Axes, Color Scales-Color as a Tool to Distinguish, Color to Represent Data Values, Color as a Tool to Highlight, Directory of Visualizations- Amounts, Distributions, Proportions, x–y relationships, Geospatial Data	8
2	Visualizing Amounts-Bar Plots, Grouped and Stacked Bars, Dot Plots and Heatmaps, Visualizing Distributions: Histograms and Density Plots- Visualizing a Single Distribution, Visualizing Multiple Distributions at the Same Time, Visualizing Distributions: Empirical Cumulative Distribution Functions and Q-Q Plots-Empirical Cumulative Distribution Functions, Highly Skewed Distributions, Quantile Plots, Visualizing Many Distributions at Once-Visualizing Distributions Along the Vertical Axis, Visualizing Distributions Along the Horizontal Axis	8
3	Visualizing Proportions-A Case for Pie Charts, A Case for Side-by-Side Bars, A Case for Stacked Bars and Stacked Densities, Visualizing Proportions Separately as Parts of the Total, Visualizing Nested Proportions- Nested Proportions Gone Wrong, Mosaic Plots and Treemaps, Nested Pies, Parallel Sets. Visualizing Associations Among Two or More Quantitative Variables-Scatterplots, Correlograms, Dimension Reduction, Paired Data. Visualizing Time Series and Other Functions of an Independent Variable-Individual Time Series, Multiple Time Series and Dose-Response Curves, Time Series of Two or More Response Variables	8
4	Visualizing Trends-Smoothing, Showing Trends with a Defined Functional Form, Detrending and Time-Series Decomposition, Visualizing Geospatial Data-Projections, Layers, Choropleth Mapping, Cartograms, Visualizing Uncertainty-Framing Probabilities as Frequencies, Visualizing the Uncertainty of Point Estimates, Visualizing the Uncertainty of Curve Fits, Hypothetical Outcome Plots	8
5	The Principle of Proportional Ink-Visualizations Along Linear Axes, Visualizations Along Logarithmic Axes, Direct Area Visualizations, Handling Overlapping Points-Partial Transparency and Jittering, 2D Histograms, Contour Lines, Common Pitfalls of Color Use-Encoding Too Much or Irrelevant Information, Using Nonmonotonic Color Scales to Encode Data Values, Not Designing for Color-Vision Deficiency.	8
	Total	40

Suggested Books

- Claus Wilke, "Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures," 1st edition, O'Reilly Media Inc, 2019.
- Tony Fischetti, Brett Lantz, R: Data Analysis and Visualization, O'Reilly ,2016
- Ossama Embarak, Data Analysis, and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems, Apress, 2018

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4AD4-21: Database Management System Lab

Credit: 1.5	Max Marks: 75 (IA :45, ETE:30)
0L+ 0T+ 3P	End Term Exams: 2hr

List of Experiments:

1. To study Basic SQL commands (create table, use , drop, insert) and execute the following queries using these commands: (CO1)
   - Create a table 'Emp' with attributes 'ename','ecity','salary','enumber','eaddress','depttname'.
   - Create another table 'Company' with attributes 'cname', ccity','empnumber' in the database 'Employee'.
2. To study the viewing commands (select, update) and execute the following queries using these commands:
   - Find the names of all employees who live in Delhi.
   - Increase the salary of all employees by Rs. 5,000.
   - Find the company names where the number of employees is greater than 10,000.
   - Change the Company City to Gurgaon where the Company name is 'TCS'.
3. To study the commands to modify the structure of the table (alter, delete) and execute the following queries using these commands:
   - Add an attribute named ' Designation' to the table 'Emp'.
   - Modify the table 'Emp', Change the datatype of 'salary' attribute to float.
   - Drop the attribute 'depttname' from the table 'emp'.
   - Delete the entries from the table ' Company' where the number of employees are less than 500.
4. To study the commands that involve compound conditions (and, or, in , not in, between , not between, like , not like) and execute the following queries using these commands:
   - Find the names of all employees who live in ' Gurgaon' and whose salary is between Rs. 20,000 and Rs. 30,000.
   - Find the names of all employees whose names begin with either letter 'A' or 'B'.
   - Find the company names where the company city is 'Delhi' and the number of employees is not between 5000 and 10,000.
   - Find the names of all companies that do not end with letter 'A'.
5. To study the aggregate functions (sum, count, max, min, average) and execute the following queries using these commands:
   - Find the sum and average of salaries of all employees in computer science department.
   - Find the number of all employees who live in Delhi.
   - Find the maximum and the minimum salary in the HR department.
6. To study the grouping commands (group by, order by) and execute the following queries using these commands:
   - List all employee names in descending order.
   - Find number of employees in each department where number of employees is greater than 5.
   - List all the department names where average salary of a department is Rs.10,000.

7. To study the commands involving data constraints and execute the following queries using these commands:
   - Alter table 'Emp' and make 'enumber' as the primary key.
   - Alter table 'Company' and add the foreign key constraint.
   - Add a check constraint in the table 'Emp' such that salary has the value between 0 and Rs.1,00,000
   - Alter table 'Company' and add unique constraint to column cname
   - Add a default constraint to column ccity of table company with the value 'Delhi'

8. To study the commands for joins (cross join, inner join, outer join) and execute the following queries using these commands:
   - Retrieve the complete record of an employee and its company from both the table using joins.
   - List all the employees working in the company 'TCS'.

9. To study the various set operations and execute the following queries using these commands:
   - List the enumber of all employees who live in Delhi and whose company is in Gurgaon or if both conditions are true.
   - List the enumber of all employees who live in Delhi but whose company is not in Gurgaon

10. To study the various scalar functions and string functions (power, square, substring, reverse, upper, lower, concatenation) and execute the following queries using these commands:
    - Reverse the names of all employees.
    - Change the names of company cities to uppercase.
    - Concatenate name and city of the employee.

11. To study the commands involving indexes and execute the following queries:
    - Create an index with attribute ename on the table employee.
    - Create a composite index with attributes cname and ccity on table company.
    - Drop all indexes created on table company.

12. To study the conditional controls and case statement in PL-SQL and execute the following queries:
    - Calculate the average salary from table 'Emp' and print increase the salary if the average
    - salary is less that 10,000.
    - Display the deptno from the employee table using the case statement if the deptname is
    - 'Technical' then deptno is 1, if the deptname is 'HR' then the deptno is 2 else deptno is 3.

13. To study procedures and triggers in PL-SQL and execute the following queries:
    - Create a procedure on table employee to display the details of employee to display the details of employees by providing them value of salaries during execution.
    - Create a trigger on table company for deletion where the whole table is displayed when delete operation is performed.

14. Consider the tables given below. The primary keys are made bold and the data types are specified.
    PERSON(driver_id:string , name:string , address:string)
    CAR(regno:string , model:string , year:int)
    ACCIDENT(report_number:int , accd_date:date , location:string)

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OWNS(driver_id:string , regno:string)
PARTICIPATED(driver_id:string , regno:string , report_number:int , damage_amount:int)

- Create the above tables by properly specifying the primary keys and foreign keys.
- Enter at least five tuples for each relation.
- Demonstrate how you Update the damage amount for the car with specific regno in the accident with report number 12 to 25000.
- Find the total number of people who owned cars that were involved in accidents in the year 2008.

Suggested Books

- Abraham Silberschatz, Henry F. Korth and S. Sudarshan- "Database System Concepts", Sixth Edition, McGraw-Hill, 2011.
- Ramez Elmasri and Shamkant B. Navathe, "Fundamental Database Systems", Seventh Edition, Pearson Education,2016

Data Base Designing Project: For better understanding students (group of 3-4 students) should design data base for any data base project, understand the requirement and design methodology of project by its own.

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4AD4-22: R Programming Lab

.Credit: 1.5	Max Marks: 75 (IA :45, ETE:30)
0L+ 0T+ 3P	End Term Exams: 2hr

S.No.	Contents
1	R for Basic Math- Arithmetic- Logarithms and Exponentials E-Notation- Assigning Objects- Vectors- Creating a Vector- Sequences, Repetition, Sorting, and Lengths- Subsetting and Element Extraction- Vector-Oriented Behavior. • Develop the R program for Basic Mathematical computation –Square, Square root, exponential, etc. • Create an object X that stores the value, then overwrite the object in by itself divided by Y. • Print the result to the console. • Create and store a sequence of values from x toy that progresses in steps of 0.3 • Overwrite the existing object using the same sequence with the order reversed. • Confirm that the length of the vector created is 20. • Extract the first and last elements of the already created vector from, storing them as a new object.
2	Matrices in R • Create and store a three-dimensional array with six layers of a 4 X 2 matrix, filled with a decreasing sequence of values between 4.8 and 0.1 of the appropriate length • Extract and store as a new object the fourth- and first-row elements, in that order, of the second column only of all layers of (1). • Use a fourfold repetition of the second row of the matrix formed in (2) to fill a new array of dimensions 2 X 2 X 2 X 3. • Create a new array comprised of the results of deleting the sixth layer of (1). • Overwrite the second and fourth-row elements of the second column of layers 1, 3, and 5 of (4) with -99.
3	Logical Values- Relational Operators- Characters- Creating a String- Concatenation- Escape Sequences Substrings and Matching- Factors- Identifying Categories- Defining and Ordering Levels- Combining and Cutting • Confirm the specific locations of elements equal to 0 in the 10 X 10 identity matrix I10 • Store this vector of 10 values: foo < c (7,5,6,1,2,10,8,3,8,2). Then, do the following: o Extract the elements greater than or equal to 5, storing the result as a bar. o Display the vector containing those elements from foo that remain after omitting all elements that are greater than or equal to 5. • Store the string "Two 6-packs for $12.99". Then do the following: o Use a check for equality to confirm that the substring beginning with character 5 and ending with character 10 is "6-pack". o Make it a better deal by changing the price to $10.99. • Create a factor with levels of confidence as follows: Low for percentages [0,30]; Moderate for percentages (30,70]; and High for percentages (70,100].

4	LISTS AND DATA FRAMES • Create a list that contains, in this order, a sequence of 20 evenly spaced numbers between -4 and 4; a 3 X 3 matrix of the logical vector c(F, T,T,T,F,T,T,F,F) filled column-wise; a character vector with the two strings "don" and "quixote"; and a factor vector containing the observations c("LOW","MED","LOW","MED","MED","HIGH"). Then, Extract row elements 2 and 1 of columns 2 and 3, in that order, of the logical matrix. • Create and store this data frame as dframe with the fields sex, funny in your R workspace. Append the two new records. • Write a single line of code that will extract from mydataframe just the names and ages of any records where the individual is female and has a level of funniness equal to Med OR High. • Use your knowledge of handling character strings in R to extract all records from mydataframe that correspond to people whose names start with S.
5	Basic Plotting • Create a database with the weight, height, and sex fields, then create a plot of weight on the x-axis and height on the y-axis. Use different point characters or colors to distinguish between males and females and provide a matching legend. Label the axes and give the plot a title. • Create a plot using ggplot2 for the same database consists of a weight on the x-axis and height on the y-axis. Use different point characters or colors to distinguish between males and females and provide a matching legend. Label the axes and give the plot a title. • Write R code that will plot education on the x-axis and income on the y-axis, with both x- and y-axis limits fixed to be [0;100]. Provide appropriate axis labels. For jobs with a prestige value of less than or equal to 80, use a black * as the point character. For jobs with prestige greater than 80, use a blue @.

Suggested Books

- Tilman M.Davies, "THE BOOK OF R - A FIRST PROGRAMMING AND STATISTICS" Library of Congress Cataloging-in-Publication Data,2016.
- Roger D. Peng," R Programming for Data Science" Lean Publishing, 2016.
- Hadley Wickham, Garrett Grolemund," R for Data Science," OREILLY Publication,2017
- Steven Keller, "R Programming for Beginners," CreateSpace Independent Publishing Platform 2016.
- Kun Ren," Learning R Programming," Packt Publishing,2016E BOOKS
- https://online-learning.harvard.edu/subject/r
- https://www.udemy.com/course/r-basics/
- https://www.datacamp.com/courses/free-introduction-to-r

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4AD4-23: Data Handling and Visualization Lab

Credit: 1.5	Max Marks: 75 (IA :45, ETE:30)
0L+ 0T+ 3P	End Term Exams: 2hr

S.No	List of Experiments
1	Download the House Pricing dataset from Kaggle and map the values to Aesthetics.
2	Use different Color scales on the Rainfall Prediction dataset
3	Create different Bar plots for variables in any dataset
4	Show an example of Skewed data and removal of skewedness
5	For a sales dataset do a Time Series visualization
6	Build a Scatterplot and suggest dimension reduction
7	Use Geospatial Data-Projections on datasets in http://www.gisinindia.com/directory/gis-data-for-india
8	Create a trend line with a confidence band in any suitable dataset
9	Illustrate Partial Transparency and Jittering
10	Illustrate usage of different color codes

Suggested Books

- Claus Wilke, "Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures", 1st edition, O'Reilly Media Inc, 2019.

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4AD4-24: Java Programming

Credit: 1.5	Max Marks: 75 (IA :45, ETE:30)
0L+ 0T+ 3P	End Term Exams: 2hr

S.No.	List of Experiments
1.	**Introductory Progam** • Write a program to print the individual digits of any 3-digit number. • Write a program to read N numbers and find the largest and smallest numbers. • Write a program to read an email as input and verify whether the email is in the correct format (***@***.**) using String functions • Write a program to display total marks of 5 students using student class. Given the following attributes: Regno(int), Name(string), Marks in subjects(Integer Array), Total (int).
2.	**INHERITANCE, PACKAGES, AND INTERFACE** • Write a program to create a player class. Inherit the classes Cricket_player, Football_player and Hockey_player form player class. • Write a program to show how a class implements two interfaces. • Write a program to create a package for Book details giving Book Name, Author Name, Price, year of publishing
3.	**EXCEPTION HANDLING AND MULTITHREADING** • Write a Java program to catch more than one exception. • Write a Java program for generating two threAD, one for printing even numbers and the other for printing odd numbers. • Write a Java program for producer and consumer problems using Thread.
4.	**INPUT/OUTPUT STREAMS** • Write a java program to copy the contents of one file to another file. • Write a Java program to read input from the standard input and write to a byte array.
5.	**WORKING WITH AWT CLASSES, SWING, APPLET, AND GRAPHICS** • Create an Applet to read the RGB components as input and create an appropriate color using the RGB values. Fill a rectangle using the obtained color. • Create an applet for a simple calculator to perform Addition, Subtraction, Multiplication and Division using Button, label, and Text field classes.

Suggested Books

- Herbert Schildt, "JAVA The Complete Reference", 10th Edition, McGraw Hill Education, 2017.
- Cay S. Horstman and Gary Cornell,"Core Java Volume I—Fundamentals", 11th Edition, Prentice

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