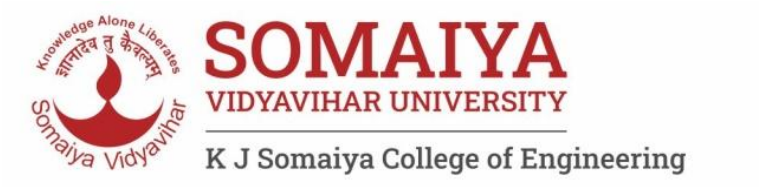


Syllabus
Second Year
B. Tech in Artificial Intelligence and Data Science

(Programme commenced from AY 2023-24)

(Department of Information Technology)

From

Academic Year 2024-25

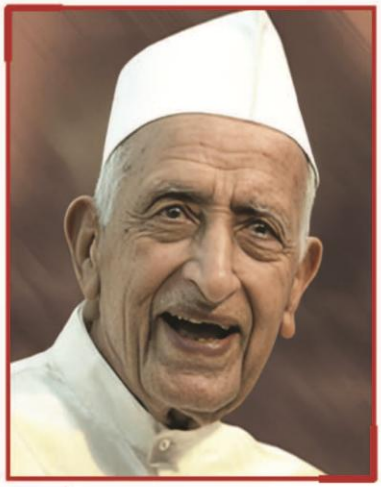
(SVU-KJSCE 2.0)

(Approved by BOS dated 25th April 2024
Academic Council dated 4th July 2024, Item No. 12.04)

SOMAIYA VIDYAVIHAR UNIVERSITY

Somaiya TRUST

Our Vision



Padma Bhushan
Shri Karamshi Jethabhai Somaiya
Our Founder

Padma Bhushan Shri Karamshi Jethabhai Somaiya's first initiative in education was the founding of a school in 1942 in rural Maharashtra, to provide quality holistic education. It was founded on the belief that education is an important pillar of nation-building with the power to change lives and that it is the duty of the privileged to provide education to the needy.

He later founded the Girivanvasi Pragati Mandal, The K J Somaiya Medical Trust, the Girivanvasi Education Trust and sister institutions to make great citizens of India and the world. In the words of Swami Vivekananda, "We want that education by which character is formed, strength of mind is increased, the intellect expanded, and by which one can stand on one's own feet." We have now grown into a multi-disciplinary and multi-campus education institution with over 1500 faculty, and 39000+ students.

ज्ञानादेव तु कैवल्यम्।

KNOWLEDGE ALONE LIBERATES

Our motto is: ज्ञानादेव तु कैवल्यम्। Knowledge alone liberates. Liberates from poverty, from hunger. Also to liberate one from the attachments that bind us to small-mindedness. Knowledge also provides opportunity. To make the life lived more meaningful. In the service of one's family, one's community, one's समाज, country, and indeed the world. Bearing in mind that there is no religion other than the life lived in the service of humanity.

न मानुषात् परो धर्मः।

We will strive to provide access and opportunity to build a more inclusive society.

Our education in any subject will reflect its timeless fundamentals, its current context, and its applications. There is so much scientific discovery taking place, at the intersection of fields, in biology, computing, medicine, the social sciences and everywhere else. We will provide students and faculty with an environment to engage with this world, discover new truths, and make new applications to create and share knowledge.

Our education will also be experiential. With projects that are 'real' and those that complement the learning inside the classroom. Our students and faculty will be at the cutting edge of change, to incubate companies, to create NGOs, and pursue any field of their passion.

Our education will also be holistic. Sports and physical exercise must be a firm part of the curriculum. For students to develop a love for sports, for recreation, for health, for teamwork, and for competition. Our education will also instil an appreciation for art, culture, nature and biodiversity.

अभ्यासेन तु कौन्तेय वैराग्येण च गृह्यते।

In the Bhagavad Gita, Arjun asks Krishna how is one to control one's mind, which is as fleeting as the wind. Krishna responds that it can only be done through practice and discipline. अभ्यासेन तु कौन्तेय वैराग्येण च गृह्यते। We will strive to teach our students to learn to stay calm in our turbulent world. And our education will also include the ancient Indian tradition, its culture, its depth, and its knowledge. We must keep the connection with our mother tongue and our languages. Languages are storehouses of culture, and the loss of a language takes with it much learning, stored through it over the ages.

Finally, our education will help students lead a full life, and to fall in love with life. Our dream is to build a world-class research and teaching institution, that is global in the reach of its ideas, and universal in its service. Welcome to our community.

Our Mission

To nurture excellence and provide freedom of possibilities in education and research to foster a culture of creativity, innovation, leadership, responsible citizenship, service, and all-round growth.

Preamble

From the Desk of Dean Faculty of Engineering and Technology:

In the era of technological revolution, engineering education must evolve to keep pace with the dynamic demands of industry and society. Our engineering institute is committed to fostering a learning environment that nurtures innovation, creativity, and a profound understanding of engineering principles. The **National Educational Policy 2020 (NEP 2020)** framed by the Government of India recommends a holistic, inclusive, and flexible approach to ensure equitable access to quality education across all levels, promote multidisciplinary research, and impart skill-based education with integration of technology.

Somaiya Vidyavihar, with its esteemed legacy in education, has consistently upheld the values of excellence, inclusivity, and innovation. Applicable for **Somaiya Vidyavihar University (SVU)'s** undergraduate engineering programs, the **SVU Scheme 2023** presented here is aligned with the transformative vision of Somaiya Vidyavihar as well as NEP 2020 to cultivate a holistic, experiential, and interdisciplinary approach to engineering education. The **salient features** of the scheme include:

Professional Core and Elective Courses: The curriculum includes state-of-the-art courses that cover both the fundamentals and emerging trends in respective branches of engineering. With an optimal balance between theoretical knowledge and practical application, core courses provide a strong foundation in essential engineering principles, while elective courses offer flexibility for students to explore and specialize in areas of interest.

Open Elective Courses: Recognizing the importance of interdisciplinary knowledge, the curriculum includes a diverse range of Open Electives categorized into four types: Open Elective Technology (OET), Open Elective Humanities, Open Elective Management (OEHM), and Open Elective Generic (OEG). These courses, offered at institute-level, enable students to expand their knowledge across various disciplines, fostering a versatile skill set and adaptability in an ever-evolving global landscape.

Innovation and Project-based Learning (PBL): The curriculum engages students in innovation and PBL through ideation, mini and major projects right from the first year to the final year of engineering. With diverse projects, collaboration, and field work/community engagement initiatives, students gain a profound understanding of engineering concepts and contribute through innovative solutions to the Sustainable Development Goals (SDGs), societal challenges and advancements.

Learning-by-Doing: The curriculum places emphasis on exposure courses through Skill-Based Learning (SBL) and Activity-Based Learning (ABL), focusing on responsibilities towards society, problem-solving abilities, leadership and teamwork, motivation for life-long learning, etc.

Elements of the Indian Knowledge System: The curriculum incorporates aspects of the Indian Knowledge System that emphasize on drawing insights from ancient wisdom and rich intellectual heritage of India to address modern challenges.

Internships and Research: Enabling students to gain industry insights and enhance their employability, the curriculum integrates flexible internship opportunities in Semester VII or VIII, allowing students to gain hands-on experience in industries, government sectors, NGOs, and MSMEs. Alternatively, they can opt for a specialized research project and courses in Semester VIII. Besides this Semester-long Internship, all the students are required to complete a mandatory 10-week internship over four years, with a maximum of 4 weeks dedicated to socially relevant internships and a minimum of 6 weeks in technical domains.

Learning through MOOCs: The curriculum leverages and promotes Massive Open Online Courses (MOOCs) to offer students flexible and diverse learning opportunities. Complementing on-campus education, students can learn through MOOCs for Open Electives – OET and OEHM during the Pre-final and Final Year, as well as Professional Core courses during their Internship.

Student Exchange Programs: The curriculum also offers student exchange programs that promote global exposure and cross-cultural learning, elevating academic and personal growth. Interested students can participate in the Student Exchange Programs as an alternative to the semester-long internship. Credits from the foreign university where they study will be transferred, providing them with an opportunity to experience different educational systems, cultures, and perspectives.

Minors Courses: Students can expand their academic horizons by pursuing minors in disciplines other than their major, earning additional credits. These minor courses provide an opportunity to acquire multidisciplinary knowledge, significantly enhancing their versatility and adaptability in the professional world.

Honors Courses: For high-achieving students, the SVU 2023 scheme offers Honors courses that delve deeper into specialized topics and gain additional credits for the same. These advanced courses align with high-end industry standards and provide an enriched learning experience, offering multiple opportunities to expand knowledge and expertise in areas of interest.

This forward-thinking SVU 2023 scheme is designed to equip our graduating engineers to emerge as innovative leaders, capable of addressing global challenges and contributing to the advancement of society. Our Boards of Studies, comprising experts in different disciplines, have meticulously designed syllabus for various programs under this SVU 2023 Scheme. We are confident that the joint efforts of the faculty, alumni, students, industry experts, and all the stakeholders will strengthen the academic, research, and entrepreneurial culture of our institution, reinforcing K. J. Somaiya College of Engineering's position as one of the premier engineering institutions in the nation and a top choice for engineering aspirants.

Dr. S. K. Ukarande

Dean – Faculty of Engineering and Technology
Somaiya Vidyavihar University, Mumbai

Preface

Welcome to the Syllabus of the Department of Artificial Intelligence and Data Science at K.J. Somaiya College of Engineering. In the age of rapid digital transformation, AI and Data Science have emerged as pivotal disciplines, driving innovation across industries worldwide. This syllabus represents our commitment to preparing you for the forefront of this technological revolution.

Our department offers a comprehensive curriculum designed to equip you with the skills, knowledge, and ethical frameworks necessary to excel in AI and Data Science. From foundational courses in machine learning and statistical analysis to advanced topics such as natural language processing and computer vision, our program is structured to provide both depth and breadth of understanding.

As you engage with our distinguished faculty who are actively engaged in cutting-edge research, you will have opportunities to explore real-world applications and contribute to advancements in AI and Data Science. Hands-on projects, industry collaborations, and internships will further enrich your learning experience, ensuring you are well-prepared to tackle complex challenges and seize opportunities in this rapidly evolving field.

We encourage you to embrace curiosity, critical thinking, and a collaborative spirit throughout your journey in our department. Your contributions to our academic community will not only shape your own future but also influence the future of AI and Data Science globally.

We are excited to embark on this transformative educational journey with you in the Department of Artificial Intelligence and Data Science

Dr. Nilkamal More

Head, Department of Information Technology

Board of Studies in Information Technology

Dr. Sonali Patil: Chairman
Dr. Parikshit Mahalle: Academician Member
Mr. Jay Visariya: Industry Member
Prof. Surya Durbha: Research Institute Member
Mr. Vivek Shah: Alumni Industry Member
Dr Nandana Prabhu: Faculty Member
Dr. Nilkamal More: Faculty Member
Student: Member
Dr. S. K. Ukarande: Dean – Faculty of Engineering and Technology

Program Outcomes (PO) – Common to all disciplines

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/Development Of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Conduct Investigations Of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, cultural, environmental, health, safety and legal issues relevant to the professional engineering practice; understanding the need of sustainable development

PO7 Multidisciplinary Competence: Recognize/study/analyze/provide solutions to real-life problems of multidisciplinary nature from diverse fields

PO8 Ethics: Apply ethical principles and commit to professional ethics, responsibilities, and norms of engineering practice.

PO9 Individual and Teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 Life-Long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO1: Articulate, design, implement reliable, scalable, secure IT based solutions using latest practices and technologies.

PSO2: Demonstrate competency of data analytics, visualization and interpretation for decision making to solve the real-world problems, using Artificial Intelligence, Machine learning and data science.

Acronyms used:

1. Acronyms for category of courses and syllabus template

Acronym	Description	Acronym	Description
BS	Basic Science Courses	**CA**	Continuous Assessment (Theory Course)
ES	Engineering Science	**ESE**	End Semester Exam
HS	Humanities, Social Sciences and Management Courses	**ISE**	In- Semester Examination
PC	Professional Core Courses	**IA**	Internal Assessment
PE	Professional Elective courses	**LAB/TUT CA**	Continuous Assessment of Laboratory/Tutorial
OET	Open Elective – Technical	**TH**	Theory
OEHM	Open Elective – Humanities and Management	**TUT**	Tutorial
OEG	Open Elective Generic	**CO**	Course Outcome
LC	Laboratory Courses	**PO**	Program Outcome
PR	Project	**PSO**	Program specific Outcome
EX	Exposure Course	**IKS**	Indian Knowledge System

2. Type of Course

Acronym	Description
C	Core Course
E	Elective Course
O	Open Elective Technical
H	Open Elective - Humanities/ Management/
R	Open Elective Generic
P	Project
L	Laboratory Course
T	Tutorial
X	Exposure course
W	Workshop
I	Indian Knowledge System

3. Eight Digit Course code e.g. 216U05C301

Acronym Serially as per code	Description
2	SVU-2023 Second Revision
16	College code
U	Alphabet code for type of program
05/06	Program code/ Common to all
C	Type of course
3	Semester number (Semester III)
01	Course serial number

SEMESTER III (With Effect from 2024-2025)

Teaching and Credit Scheme

Course Code	Course Category	Name of the Course	Teaching Scheme TH-PR-TUT	Total (hrs.)	Credit Scheme TH-PR-TUT	Total Credits
216U42C301	ES	Calculus, Linear algebra and Discrete Mathematics	3 – 0 – 1	04	3 – 0 – 1	04
216U42C302	PC	Data Structures $	3 – 0 – 0	03	3 – 0– 0	03
216U42C303	PC	Database Management Systems	3 – 0– 0	03	3 – 0 – 0	03
216U42C304	PC	Fundamentals of Data Science	3 – 0– 0	03	3 – 0– 0	03
216U42C305	PC	Digital Systems	3 – 0--0	03	3 – 0 – 0	03
216U06I306	IKS	Indian Knowledge System	2 – 0– 0	02	2 – 0– 0	02
216U42L301	LC	Object Oriented Programming Laboratory @	0 – 2 – 2	04	0 – 1 – 2	03
216U42L302	PC	Data Structures Laboratory	0 – 2 – 0	02	0 – 1 – 0	0 1
216U42L303	PC	Database Management Systems Laboratory	0 – 2 – 0	02	0 – 1 – 0	0 1
216U42L304	PC	Fundamentals of Data Science Laboratory	0 – 2 – 0	02	0 – 1 – 0	0 1
			17 – 08– 03	**28**	**17 – 04 – 03**	**24**

@ Students will have a choice of Java or Advanced Python or C++ language

$ Common with IT department

Evaluation Scheme

Course Code	Name of the Course	LAB/ TUT CA	CA		ESE	Total
			IA	ISE		
216U42C301	Calculus, Linear algebra, and Discrete Mathematics	25	20	30	50	125
216U42C302	Data Structures	--	20	30	50	100
216U42C303	Database Management Systems	--	20	30	50	100
216U42C304	Fundamentals of Data Science	--	20	30	50	100
216U42C305	Digital Systems	--	20	30	50	100
216U06I306	Indian Knowledge System	--	50	--	--	50
216U42L301	Object Oriented Programming Laboratory @	75	--	--	--	75
216U42L302	Data Structures Laboratory	50	--	--	--	50
216U42L303	Database Management Systems Laboratory	50	--	--	--	50
216U42L304	Fundamentals of Data Science Laboratory	50	--	--	--	50
	Total	**250**	**150**	**150**	**250**	**800**

@ Students will have a choice of Java or Advanced Python or C++ language

SEMESTER IV (With Effect from 2024-2025)

Teaching and Credit Scheme

Course Code	Course Category	Name of the Course	Teaching Scheme TH-PR-TUT	Total (hrs.)	Credit Scheme TH-PR-TUT	Total Credits
216U42C401	ES	Statistics, Probability and Optimization Techniques	3 –0 – 1	04	3 –0 –1	04
216U42C402	PC	Analysis of Algorithms	3 – 0 – 0	03	3 – 0 – 0	03
216U42C403	PC	Artificial Intelligence	3 – 0 – 0	03	3 – 0 – 0	03
216U42C404	PC	Operating Systems	3 – 0 – 0	03	3 – 0 – 0	03
216U42C405	PC	Computer Network and Information Security	3 – 0 – 0	03	3 – 0 – 0	03
216U06R4XX	OEG	Open Elective (Generic)	3 – 0 - 0	03	3 – 0 – 0	03
216U42L401	LC	Data Visualization Laboratory	0 – 2 – 0	02	0 – 1 – 0	01
216U42L402	PC	Analysis of Algorithms Laboratory	0 – 2 – 0	02	0 – 1 – 0	01
216U42L403	PC	Artificial Intelligence Laboratory	0 – 2 – 0	02	0 – 1 – 0	01
216U42L404	PC	Operating Systems Laboratory	0 – 2 – 0	02	0 – 1 – 0	01
216U42L405	PC	Computer Network and Information Security Laboratory	0 – 2 – 0	02	0 – 1 – 0	01
			18 – 10– 01	**29**	**18 – 05 – 01**	**24**

Evaluation Scheme

Course Code	Name of the Course	LAB/ TUT CA	CA		ESE	Total
			IA	ISE		
216U42C401	Statistics, Probability and Optimization Techniques	25	20	30	50	125
216U42C402	Analysis of Algorithms	--	20	30	50	100
216U42C403	Artificial Intelligence	--	20	30	50	100
216U42C404	Operating Systems	--	20	30	50	100
216U42C405	Computer Network and Information Security	--	20	30	50	100
216U06R4XX	Open Elective (Generic)	--	100	--	--	100
216U42L401	Data Visualization Laboratory	75	--	--	--	75
216U42L402	Analysis of Algorithms Laboratory	50	--	--	--	50
216U42L403	Artificial Intelligence Laboratory	50	--	--	--	50
216U42L404	Operating Systems Laboratory	50	--	--	--	50
216U42L405	Computer Network and Information Security Laboratory	50	--	--	--	50
		300	**200**	**150**	**250**	**900**

Open Elective Generic (OEG) as offered for AY 2024-25

Course Code	Course Name
216U06R401	Ancient Indian Iconography
216U06R402	French Culture and Civilization
216U06R403	German Culture and Society
216U06R404	Indian Cinema: History and Appreciation
216U06R405	Indian Civilization
216U06R406	Literature of Resistance
216U06R407	Marathi Kavita
216U06R408	Maritime Seafaring and Shipbuilding
216U06R409	Mountains, People and Cultures
216U06R410	Philosophy of Science
216U06R411	The Non-Human Species Depicted in Literature
216U06R412	World Civilizations
216U06R413	Physics and Philosophy

Semester III

SY B. Tech. AI & DS

(KJSCE SVU 2023)

Course Code	Course Title			
216U42C301	Calculus, Linear algebra and Discrete Mathematics			
	TH	P	TUT+	Total
Teaching Scheme (Hrs.)	03	--	01	04
Credits Assigned	03	--	01	04

Examination Scheme	Marks				
	LAB/TUT CA	CA (TH)		ESE	Total
		IA	ISE		
	25	20	30	50	125

+Batch wise Tutorial

Course prerequisites: Applied Mathematics-I, Applied Mathematics –II

Course Objectives:

The objective of this course is to introduce various concepts of Linear algebra which will be useful to learn data science. The course acquaints students with concepts of Gradient decent and various vector operators. The course also familiarizes students with the concepts of Relations, functions and Posets. It will introduce the students with different concepts of graphs and Trees.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1. Apply concepts of vector spaces to find rank, dimension of spaces and study their linear transformations.

CO2. Find Gradient descent, Jacobian, Hessian and Laplacian of vector functions.

CO3. Apply Relations, Functions and Posets to solve Engineering problems.

CO4. Apply various concepts of Graph theory to solve Engineering problems.

Module No.	Unit No	Details	Hrs.	CO
1	**Linear Algebra**		12	CO1
	1.1	Vectors in vector space over real field, properties, dot product, cross product, Norm and distance.		
	1.2	Subspaces, linear dependence and independence of vectors, Linear Span, Basis and Dimension of a vector space.		
	1.3	Linear transformation, Kernel, Rank nullity theorem. Orthogonal compliments and projection		
2	**Calculus**		12	CO2
	2.1	Scalar and vector functions, Gradient of scalar point function, Directional derivatives, Jacobian, Hessian, Laplacian.		
	2.2	Local and global maxima or minima, saddle points, convex functions and properties, gradient descent method		
	2.3	Tensor and Tensor analysis		
3	**Relations and Functions**		11	CO3
	3.1	Pigeonhole and Extended Pigeonhole principle.		
	3.2	Relations: Definition, Types of relations, Equivalence relations, Partial ordering relations		
	3.3	Functions: Definition, Types of functions: Injective, Surjective, Bijective, Invertible function, Composite function.		
	3.4	Posets, Hasse Diagram, Lattices and Types of lattices		
4	**Graph Theory**		10	CO4
	4.1	Introduction to graphs, graph terminology, representing graphs and graph isomorphism.		
	4.2	Types of graph, Connectivity, Edge and vertex connectivity, Euler and Hamilton paths. Travelling Salesperson problem.		
	4.3	Introduction to trees, Isomorphism of trees, Minimal spanning Tree (M.S.T.), Prefix code, Huffman procedure, Application of trees to coding and decoding of a message		
		Total	45	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	B. S. Grewal	*Higher Engineering Mathematics*	Khanna Publications, India	43rd Edition 2014
2.	Erwin Kreyszig	*Advanced Engineering Mathematics*	Wiley Eastern Limited, India	10th Edition 2015
3.	N.P. Bali and Manish Goyal	*A Textbook of Engineering Mathematics*	Laxmi Publications LTD, India	9th Edition 2016
4.	Kenneth Rosen	*Discrete Mathematics and Its Applications*	McGraw-Hill Education	6th Edition

TUT CA will consist of Tutorials covering entire syllabus of "Calculus, Linear algebra and Discrete Mathematics" (216U42C301). Students will be graded based on continuous assessment of their tutorial CA. At least 2 tutorials will be conducted with the help of Mathematical and Statistical software in the Laboratory.

Course Code	Course Title			
216U42C302	Data Structures $			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	LAB/TUT CA	CA (TH)		ESE	Total
		IA	ISE		
	--	20	30	50	100

$- Common with IT Department

Course prerequisites: Programming Language

Course Objectives:

The objective of this course is to introduce different types of data structure and how user can use data structure in software development. The course also familiarizes students with the concepts of advanced data structures such as balanced search trees, hash tables, priority queues, sorting and searching. Students will be master in the implementation of linked data structures such as linked lists and binary trees using any preferable language. Course mainly focuses on choosing the appropriate data structure for a specified application.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1. Comprehend the different data structures used in problem solving.
CO2. Apply linear and non-linear data structure in application development.
CO3. Implement concepts of advance data structures like set, map & dictionary.
CO4. Demonstrate sorting and searching methods.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Data Structures**		5	CO1
	1.1	Defining Data structure, Types of Data Structures, Abstract Data Type (ADT), Static and Dynamic Implementations, Introduction to space and time complexity, O notation		
	1.2	Applications of data structures.		
2	**Linear data structures: Linked List, Stack and Queue**		16	CO2
	2.1	Introduction and Representation of Linked List, Linked List v/s Array, Implementation of Linked List, Circular Linked List, Doubly Linked List, Application– Polynomial Representation and Addition, Other additional applications/Case study.		
		#Self-learning - Sparse matrix addition		
	2.2	The Stack as an ADT, Stack operations, Array Representation of Stack, Linked Representation of Stack, Application of stack – Polish Notation, Recursion and other applications/Case study, **Application of stack in conversion and evaluation of postfix and prefix expression.**		
	2.3	The Queue as an ADT, Queue operation, Array Representation of Queue, Linked Representation of Queue, Circular Queue, Priority Queue, and Double ended queue, Application of Queues – Simulation and other applications/Case study, **Application of queue in Josephus's Problem.**		
3	**Non-linear data structures: Tree and Graph**		12	CO3
	3.1	Basic tree terminologies, Types of trees, Binary tree representation, Binary tree operation, Binary tree traversal, Binary search tree implementation, Threaded binary trees. Different Search Trees -AVL tree, Overview-Trie, Suffix tree, Applications/Case study of trees.		
		#Self-learning– Red-Black and Splay Trees, Multiway Search Tree, B Tree, B+ Tree		
	3.2	Introduction to graph as a data structure, Terminologies, Representation, Traversals – Depth First Search (DFS) and Breadth First Search (BFS). Applications/Case study of Graphs.		
4	**Set, Map and Dictionary**		7	CO3
	4.1	Set ADT, Set Implementation, and Partitions with Union-Find operations, Tree based partition implementation.		
	4.2	Map ADT, Implementation, Hash Tables Application of Maps		
		#Self-Learning - ***Dictionary ADT, Implementation, Application of Dictionaries, Exploring case studies on use of set, map and dictionary**		
5	**Searching and Sorting**		5	CO4
	5.1	Sort Concept: Sort Stability, in place sort, number of passes, Bubble Sort, Radix Sort		
		#Self-learning - Bucket and Shell sort		
	5.2	Search concept: Linear Search, Binary Search,		

		Hashing, collision resolution: Separate chaining, Linear probing, quadratic probing, double hashing		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed	*Fundamentals Of Data Structures In C*	University Press	Second Edition 2008
2.	Michael T Goodrich Roberto Tamassia David Mount	*Data Structure and Algorithm in C++*	Wiley	Second Edition 2011
3.	Richard F. Gilberg & Behrouz A. Forouzan	*Data Structures A Pseudocode Approach with C*	CENGAGE Learning	Second Edition 2005
4.	Aaron M Tanenbaum Yedidyah Langsam Moshe J Augentstein	*Data structure Using C*	Pearson	Twelth Impression 2013
5.	Jean Paul Tremblay, Paul G. Sorenson	*An introduction to data structures with applications*	Tata McGraw-Hill Education	Second Edition 1984

Course Code	Course Title			
216U42C303	Database Management Systems			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	LAB/TUT CA	CA (TH)		ESE	Total
		IA	ISE		
	--	20	30	50	100

Course Prerequisites: Nil

Course Objectives:

This course is imparting knowledge of database management systems and its use in enterprise business. It enables students to perform entity-relationship modeling and relational database design Students will learn and use Structured Query Language (SQL). It gives knowledge of applying normalization techniques to the database. Students are also introduced to the concept of indexing, transactions and query processing.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1. Comprehend the features of relational database management systems.
CO2. Apply data models to real world scenarios.
CO3. Illustrate the concept of security, query processing, indexing and normalization for relational databases.
CO4. Apply the concept of transaction, concurrency control and recovery techniques.

Module No.	Unit No.	Details	Hrs.	CO
1	**Database Concepts and Systems**		6	CO1
	1.1	Introduction**,** Purpose of Database Systems, DBMS System Architecture, Data Models, Data Independence		
	1.2	Database Languages, Database Users and Administrator		
	1.3	Different types of Traditional Database Systems		
	1.4	Introduction to No-SQL Databases		
2	**Database Models and SQL**		9	CO2
	2.1	Database Design Phases, E-R Model		
	2.2	Constraints, E-R Diagram, E-R Design Issues		
	2.3	Entity Set, Extended E-R Features		
	2.4	Relational Model Concepts, Constraints		
	2.5	Relational Algebra, Unary, Binary and Set Theory Relational Operations		
	2.6	Data Definition Commands, Attribute Constraints, SET Operations, Aggregate Functions, Null Values, Nested Sub Queries, Complex Queries, Views, Data Control Commands		
	2.7	Data Manipulation Commands, Insert, Update, Join Relations		
	2.8	Integrity and Security, Domain Constraints, Referential Integrity, Triggers, Security and Authorization in SQL		
3	**Relational Database Design**		10	CO3
	3.1	Design Guidelines for Relational Schemas, Functional Dependencies		
	3.2	First Normal Form, Second Normal Form, Third Normal Form.		
	3.3	Decomposition using Functional Dependencies, Boyce Codd Normal Form, Decomposition using Multivalued Dependencies, Fourth Normal Form.		
	3.4	Database Design and Implementation Process		
4	**Indexing, Hashing, Query processing and Optimization**		10	CO3
	4.1	Basic Concepts, Ordered Indices, Dense and Sparse, Multilevel Indices, Secondary Indices		
	4.2	Hashing, Static Hashing, Dynamic Hashing, Comparison of Ordered Indexing and Hashing		
	4.3	Query Processing, Steps involved in Query Processing, Measures of Query Cost, Algorithms for SELECT and PROJECT Operations		
	4.4	Query Optimization Overview, Transformation of Relational Expressions, Estimating Statistics, Choice of Evaluation Plan		
5	**Transactions, Concurrency Control and Recovery System**		10	CO4
	5.1	Transaction Concepts, Transaction State, ACID Properties, Concurrent Executions, Serializability, Recoverability.		
	5.2	Concurrency Control, Lock Based, Timestamp Based, Validation Based Protocol, Deadlock Handling		
	5.3	Recovery System, Failure Classification, Recovery and Atomicity, Log Based Recovery, Shadow Paging		
		Total	45	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Elmasri and Navathe	*Fundamentals of Database Systems*	Pearson Education	7th Edition 2017
2.	Korth, Slberchatz, Sudarshan	*Database System Concepts*	McGraw – Hill	7th Edition 2021
3.	Raghu Ramakrishnan and Johannes Gehrke	*Database Management Systems*	McGraw Hill	3rd Edition 2002
4.	Alan Beaulieu	*Learning SQL: Generate, Manipulate, and Retrieve Data*	O'Reilly	3rd Edition 2020
5.	Thomas Connolly, Carolyn Begg	*Database Systems: A Practical Approach to Design, Implementation, and Management*	Pearson	6th Edition 2019

Course Code	Course Title			
216U42C304	Fundamentals of Data Science			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	LAB/TUT CA	CA (TH)		ESE	Total
		IA	ISE		
	--	20	30	50	100

Course prerequisites: Basic concepts of databases

Course Objectives: This course includes the processes essential to perform initial investigations on data so as to discover patterns, to spot anomalies, to test hypotheses and to check assumptions with the help of summary statistics and visual representations. Also, it covers the techniques to optimize the parameters required in classification approach. It attempts to understand the data first and then efforts can be applied to extract as many insights from it using different visualization tools.

At the end of successful completion of the course the student will be able to

CO1: Summarize the data.

CO2: Comprehend descriptive and proximity measures of data.

CO3: Apply the transformations required on data to make it suitable for mining.

CO4: Comprehend various data visualization techniques and its interpretations.

Module No.	Unit No.	Details	Hrs	COs
1.	**Introduction to data**		6	CO1
	1.1	Understanding data, Types of attributes, Nominal, ordinal, interval, ratio, Discrete and continuous attributes		
	1.2	Types of datasets: Record data, Graph-based data, Sequence data, time series data, spatial data, General characteristics of datasets		
	1.3	Data Science Vs Data Analytics Vs Data Engineering, Exploratory Data Analysis different from classical data analytics		
	1.4	Application of Data science in real world: Medical and Healthcare, Agriculture, Disaster Management etc.		
2.	**Exploring data using descriptive measures**		12	CO 2, CO 4
	2.1	Measures of central tendency: Mean (Arithmetic, weighted and geometric mean), median, mode, range, Group Data Mean, Mode, Median, standard deviation, Variance		
	2.2	Measures of dispersion: correlation, covariance, inter-quartile range, root mean square deviation, coefficients of dispersion based upon range, quartile deviation, mean deviation, coefficient based upon moments, ANOVA		
	2.3	Boxplot, Quantile–Quantile Plot, Scatter Plots/Pair-plot and its limitations, Outlier, Detection of outlier through visualization techniques and interpretations. Skewness: Measures of Skewness, Kurtosis, Pearson's coefficient, Bowles coefficient		
3.	**Data similarity and dissimilarity**		9	CO2
	3..1	Similarity measures for numeric data, Minkowski distance, Euclidean distance, Manhattan distance, supremum distance, Mahalanobis distance, Bhattacharyya distance		
	3.2	Similarity measures for symmetric and asymmetric binary data, simple matching coefficient, Jaccard coefficient, hamming distance		
	3.3	Similarity measures for textual data, edit distance, cosine distance, Jaro distance, n-Gram distance, longest common subsequence		
	3.4	Dissimilarity between attributes of mixed type		
4	**Data Normalization, discretization and reduction techniques**		10	CO3
	4.1	Introduction to Data Mining, Data quality problems, issues related to applications, Predicting missing data using regression modeling and using interpolation technique, data transformations to make data suitable for data mining		

	4.2	Standardization of data, Data Normalization, Min-Max normalization, z-score normalization, Decimal scaling		
	4.3	Data discretization using Binning, Histogram, Clustering, Decision Tree Analysis		
	4.4	Attribute subset selection, Sampling.		
5.	**Data Visualization and interpretation**		**8**	**CO4**
	5.1	Frequency distribution: simple, grouped, cumulative and relative frequency distribution, graphs for frequency distribution (Histogram, frequency polygon, frequency curve, cumulative frequency curve)		
	5.2	Understand different graphs and charts and its interpretations, Visualizing complex data and Relations, Scoreboard and Dashboard		
		Total	**45**	

Recommended Books:

Sr.No.	**Name/s of Author/s**	**Title of Book**	**Name of Publisher with country**	**Edition and Year of Publication**
1.	S.C. Gupta , V. K. Kapoor	*Fundamentals of mathematical statistics*	Sultan Chand and Sons	2020
2.	P. N. Tan, M. Steinbach, Vipin Kumar,	*Introduction to Data Mining*	Pearson Education,	2016
3.	Han, Kamber	*Data Mining Concepts and Techniques*	Morgan Kaufmann	3rd Edition 2012
4.	C. B. Gupta, Vijay Gupta	*An Introduction to Statistical Methods*	Sultan Chand and Sons	23rd Edition, 2004
5.	Colin Ware	*Information Visualization: Perception for Design*	MK publication	May 2020, 4th Edition
6.	Michael Berry and Gordon Linoff	*Data Mining Techniques*	Wiley Publications	2nd Edition, 2011

Course Code	Course Title			
216U42C305	Digital Systems			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	LAB/TUT CA	CA (TH)		ESE	Total
		IA	ISE		
	--	20	30	50	100

Course prerequisites: Nil

Course Objectives:

This course lays the foundation for understanding the basics of digital Logic Design as well as Computer Organization and Architecture.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO 1. Solve problems on various number systems, Boolean algebra and graphical techniques.
CO 2. Understand the basic building blocks, techniques used in digital logic design.
CO 3. Design the combinational and sequential circuits using basic building blocks.
CO 4. Understand the basic concepts of memory elements.
CO 5. Understand the fundamental concepts of microprocessors.

Module No.	Unit No.	Details	Hrs.	CO
1	**Number Systems, Codes, Logic gates and Simplification Techniques**		13	CO1
	1.1	Introduction to digital Systems, Number systems- Binary, octal, and hexa-decimal number systems, Codes- Binary code, BCD code, gray code, ASCII code		
	1.2	Binary Arithmetic, Binary Addition and Subtraction (1's and 2's complement method)		
	1.3	Basic Digital Circuits: NOT, AND, OR, NAND, NOR, EXOR, EX-NOR		
	1.4	Theorems and Properties of Boolean Algebra, Standard SOP and POS form. Simplification of expressions, K-map method (2,3,4), NAND-NOR Realization.		
2	**Combinational Logic Design**		09	CO2
	2.1	Introduction to combinational logic design, Half and Full Adder, Half and Full Subtractor, Ripple carry Adder, Magnitude comparator		
	2.2	Multiplexers and De-multiplexers/Decoder, Binary Encoder, Priority Encoder, Code Conversion.		
	2.3	Design of combinational logic systems using Logic gates , Multiplexer, Demultiplexer, Encoder and Decoder		
3	**Sequential Logic Design**		10	CO3
	3.1	Flip Flops: SR, D, JK, JK Master Slave and T Flip Flop, Truth Tables and Excitation Tables, Flip-flop conversion		
	3.2	Counters: Design of Asynchronous and Synchronous Counters, Modulo Counters, Up- Down counter.		
	3.3	Shift Registers: Bidirectional Shift Register, Ring and Johnson Counter.		
4	**Functional Units of Digital Systems**		07	CO4
	4.1	Functional units of Computer, Basic Instruction Cycle, Interrupts		
	4.2	Memory sub-system-Typical architecture of RAM and ROM, SRAM and DRAM – architecture and comparison, • Basic Structure of flash / SSD, Memory hierarchy		
5	**Introduction to Microprocessors**		06	CO5
	5.1	Introduction to Functional Block diagram of microprocessor 8086		
	5.2	MOV Instruction Formats, Addressing modes of microprocessor 8086		
	5.3	Segmented memory and interleaved memory architecture in 8086		
		Total	45	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1	R. P. Jain	*Modern Digital Electronics*	Tata McGraw Hill	4th Edition, 2009
2	Donald P Leach, Albert Paul Malvino	*Digital principles and Applications*	Tata McGraw Hill	8 th Edition, 2014
3	William Stallings	*Computer Organization and Architecture*	Pearson Education India	11th Edition, 2019
4	D. V. Hall,	*Microprocessor and Interfacing Programming Hardware*	Tata McGraw Hill	2nd Edition, 2006
5.	Shibu K. V.	*Introduction to embedded Systems*	McGraw Hill Education India Private Limited	2nd edition, July 2017

Course Code	Name of the Course			
216U06I306	Indian Knowledge System			
Teaching Scheme (Hrs./Week)	TH	P	TUT	Total
	02	--	--	02
Credits Assigned	02	--	--	02

Evaluation Scheme	Marks				
	LAB/TUT CA	CA (TH)		ESE	Total
		IA	ISE		
	--	50	--	--	50

Course pre-requisites:
Nil

Course Objectives:
1. To introduce students to the rich diversity of Indian knowledge systems
2. To introduce the life and works of important figures in the respective domains
3. To explore the underlying philosophical and cultural ethos that distinguishes Indian Knowledge Systems
4. To emphasize continuity of the tradition into modern times, wherever applicable.

Course Outcomes (CO):
At the end of successful completion of the course the student will be able to
CO1. Understand different domains of Indian Knowledge Systems.
CO2. Explore the contribution of great figures in the respective fields.
CO3. Explain how culture impacts creation of knowledge.
CO4. Investigate correlations and synthesis leading to development of any knowledge system.

Module No.	Unit No.	Contents	No. of Hrs.	Hours per Unit
1	**Sources of Indian Knowledge Systems**			**4**
	1.1	IKS - Concept, scope, relevance to our world today.	1	
	1.2	Textual sources, historical accounts, archaeological evidence, inscriptions, coins etc	3	
2	**Why study IKS?**			**2**
	2.1	Importance of the IKS, its interconnections and relevance to the modern fields of science.	2	
3	**Yoga: Basic Practices and Philosophy**			**6**
	2.1	Maharshi Patanjali, Swami Satyananda Saraswati, B K S Iyengar, Swami Kuvalayananda, Sri Yogendra	2	
	2.2	Body loosening exercises Importance of breath, developing concentration Yoga for mind-body wellness	2	
4	**Genres of Ancient Literature**			**6**
	4.1	Religious: Vedic texts, Buddhist and Jain texts;	2	
	4.2	Epics, Puranas, Sangam literature	2	
	4.3	Poetry, Mathematics, and Scientific Literature	2	
5	**Leadership and Ethical Values**			**6**
	5.1	Selections from Shantiparva of Mahabharata, Arthasastra, Panchatantra, Hitopadesha, Jataka tales, Bhagavadgita, Dhammapada and Thirukkural: Discussions on ethical values	3	
	5.2	Leadership qualities as reflected through ancient Indian literature: Lessons for modern leadership challenges	3	
6	6.1	**Art:** **Sculpture(iconography) and Paintings**	3	
		Iconography: Ellora (Buddhist and Jain) and Hampi (Hindu)		
		Paintings: Ajanta(Buddhist), Ellora(Jain), Brihadeshvar Temple-Thanjavur.(Hindu)		
	6.2	**Architecture:** **Rock-cut caves and Temple Architecture**	3	
		Rock-cut caves: Kanheri, Elephanta, Ellora (any two sites can be used for detailed discussion)		
		Temple architecture: Pattadakal, Konark Temple, Jagannatha Temple-Puri, Bodh Gaya, Dilwara Temple-Mount Abu (any two sites can be used for detailed discussion)		
7		**Ancient Indian Mathematics**		**6**
	7.1	Shulba Sutras, Bakshali Manuscript	2	

	7.2	Aryabhatiya: place value system, approximation of the value of π, geometry	2	
	7.3	Bhaskaracharya: different approach to teaching mathematics	2	
8		**Ancient Indian Astronomy**		**6**
	8.1	Indian calendar system: Sayana-nirayana calendar, Panchanga	3	
	8.2	Spherical trigonometry, Eclipse computation	3	
9		**Ancient Indian Agriculture**		**6**
	9.1	General management of Agriculture and Farming Operations	3	
	9.2	Cattle Management, Weather predictions	3	
10		**Trade and Commerce**		**6**
	10.1	Silk route, Uttarapatha and Dakshinapatha, Maritime route	3	
	10.2	Barter system, Numismatics	3	
11		**Ancient Indian Society**		**6**
	11.1	Law and Justice	3	
	11.2	Marriage Laws, Inheritance	3	
12		**Chemistry and Metallurgy**		**6**
	12.1	Multiple sources such as archaeological artifacts, temple icons,	1	
	12.2	Metals and beads	2	
	12.3	Chemistry of dyes, Colouring materials	2	
	12.4	Paintings and Painting materials	1	
			Total Hours	**30***

* The first two modules remain the core and other modules can be selected (any 4 modules from module 3 to module 12) by the college depending upon the availability of the teachers making it to a 30hrs course.

References

Textbook on IKS:

Sr. No.	Name/s of Author/s	Title of Book	Publisher	Edition/ Year
1	Mahadevan B., Bhat Vinayak Rajat, Nagendra Pavana R. N.	*Introduction to Indian Knowledge System: concepts and Applications*	PHI Learning Pvt. Ltd.	2022

References Books:

Sr. No.	Name/s of Author/s	Title of Book	Publisher	Edition/ Year
1	Amma Sarasvati T. A.	*Geometry in Ancient and Medieval India*	MLBD, Delhi	1st ed. 1999, reprint 2007
2	Acharya, P. K.	*Indian Architecture According to ManasaraShilapshastra*	Oxford University Press	1927
3	Altekar, A.S.	*Education in Ancient India*	Gyan Books	2010
4	Appleton Naomi	*Study of Vastuvidya or Canon of Indian Architecture*	Patna	1976

5	Bhatacharyya, T.	*Study of Vastuvidya or Canon of Indian Architecture*	Patna	1976
6	Bose, N. K.	*Orissan temple Temple Architecture (Vastushastra) [With Sanskrit text and English translation)*	Bharatiya Kala Prakashana, Delhi	2017
7	Chatterjee, Satischandra & Datta, Dhirendra Mohan	*An introduction to Indian Philosophy*	Rupa Publications India Pvt. Ltd., New Delhi	7th edition, 1968
8	Clark Walter Eugene	*The Aryabhatiya of Aryabhata- An Ancient Indian Work On Mathematics and Astronomy*	Delta Book World, India	2021
9	Coomaraswamy, Ananda K	*Early Indian Architecture: Cities and City-Gates*	Munshiram Manoharlal Publishers	2002
10	D M Bose, S N Sen and B V Subbarayappa, eds	*A Concise History of Science in India*	INSA	2009
11	Datta Bibhutibhushan & Singh Avadhesh Narayan	*History of Hindu Mathematics*	1935, repr. Bharatiya Kala Prakashan, Delhi	2004
12	Datta Bibhutibhushan	*Ancient Hindu Geometry: The Science of the Śulba*	1932, reprint. Cosmo Publications, New Delhi	1993
13	Deglurkar, G. B	*Temple Architecture and Sculpture of Maharashtra*	Nagpur University, Nagpur	1974
14	Dehejia, Vidya	*Early Buddhist Rock Temples A Chronological Study*	London	1972
15	Dehejia, Vidya	*Early Stone Temples of Orissa*	Vikas Publishing House, Delhi	1979
16	Divakaran P. P.	*The Mathematics of India: Concepts, Methods, Connections*	Hindustan Book Agency	2018
17	Dr. Mishra Shiv Shekhar	*Fine Arts & Technical Sciences in Ancient India with special reference to Someśvara's Mānasollāsa*	Krishnadas Academy, Varanasi	1982
18	Ed. and Trs. Majumdar Girija Prasanna, Banerji Sures Chandra	*Krisi-Parasara*	Asiatic Society, Kolkata	1960
19	Ed. Tr. Kangale, R. P	*Kautiliya Arthashastra*	University of Bombay, Bombay	1960

20	Gupta, Swarajya Prakash, Asthana Shashi	*Elements of Indian Art: Including Temple Architecture, Iconography & Iconometry*	Indraprastha Museum of Art and Archeology	2007
21	Kane P.V.	*History of Sanskrit Poetics*	Motilal Banarasidass, New Delhi	4th edition, 1971
22	Larson, G. J. (Ed.) and Bhattacharya, R. (Ed.)	*Encyclopaedia of Indian Philosophies: Yoga: India's Philosophy of Meditation, Vol. XII*	Motilal Banarasidas Publishers Pvt. Ltd., Delhi	1st edi., 2008
23	Paranjpe Kalpana	*Ancient Indian insights and Modern Science: A Rare Book*	Bhandarkar Oriental Research Institute, Pune	2022
24	Radhakrishnan, S.	*The Principal Upanisads*	Oxford University Press, Delhi	1992
25	Rahman A., Alvi M. AKhan. S A., Ghori, Murthy Samba K. V.	*Science and Technology in Medieval India - A Bibliography of Source Materials in Sanskrit*	Arabic and Persian	1982
26	Rao Balachandra S.	*Indian Astronomy – An Introduction*	Universities Press (India) Limited, Hyderabad	2000
27	Rao Balachandra S.,	*Indian Mathematics and Astronomy: Some Landmarks*	Jnana Deep Publications, Bangalore	3rd edn, 2004
28	Rao, S. Balachandra	*Ancient Indian Astronomy, Planetary Positions and Eclipses*	B.R. Publications	2000
29	Satwalekar S.D.,	*Mahabharata*	Svadhyay Mandal, paradi	1968
30	Sharma Sharmishtha	*Buddhist Avadanas, (Socio political, Economic and Cultural Study)*	Eastern book Linkers, Delhi	1985
31	Subbarayappa B.V.	*Science in India: A Historical Perspective*	Rupa, New Delhi,	2013
32	Taimini, I. K.	*The Science of Yoga*	The Philosophical Publishing House, Adyar	1999
33	Arup Kaul	*Valmiki Ramayana*	Nag Publishers	1990
34	Vatasyayan, Kapila	*The Square and the Circle of the Indian Arts*	Abhinav Publication	1997

Notes to the teachers:

1) Pedagogy:

For effective content delivery, innovative teaching-learning methods will be extremely important. The use of ICT tools, resources from museums and other websites, can be tapped and a repository of common resources can be created across institutions. Classroom sessions can be supplemented with site-based learning at a heritage site nearby, a local museum or a shrine, when studying ancient Indian art and architecture. Immersive experiences will have a powerful impact in units on Yoga, and the performing arts.

The teacher should also make all efforts to incorporate analysis from multiple dimensions such as history, cultural and local significance, and contribution to the economic, social, cultural or literary developments.

The multidisciplinary dimension of each unit should be explored and all attempts must be made to sensitise students to the syncretic nature of Indian culture.

2) Units in the Syllabus:

Recognising that it may not always be possible to find trained faculty for some of the units a list of alternative units is provided in the above syllabus. The first two modules remain the core and other modules can be selected (any 4 modules from module 3 to module 12) by the college depending upon the availability of the teachers making it to a 30hrs course.

3) Assessment:

The model syllabus recommends a 50:50 ratio between Continuous Assessment and End Semester Examination. Innovative methods like MCQ test on each unit, report on a site visit in written or video format, role play and group discussions, or an essay on the experiential content of Yoga, could be included in continuous assessment. The End Semester Exam can be in open book format.

Course Code	Course Title			
216U42 L301	Object Oriented Programming Laboratory @			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	–	2	2	4
Credits Assigned	–	1	2	3

Examination Scheme	Marks				
	LAB/TUT CA*	CA (TH)		ESE	Total
		IA	ISE		
	75	–	–	–	75

@Java

Course prerequisites: Basics of programming language

Course Objectives:

The objective of the course is to impart knowledge of Java Programming language. The course introduces the implementation of Object Oriented Methodology concepts to solve problems using Java Programming. Further the course also covers concepts of Packages, Multithreading, Collection classes, GUI programming with JDBC and Functional Programming in java

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1: Apply fundamental Object Oriented Methodology concepts using java programming.
CO2: Apply String manipulation functions, inheritance and polymorphism using Java programming.
CO3: Demonstrate the concept of packages, multithreading, and exception handling in java.
CO4: Illustrate the use of collection classes, functional programming, and GUI programming with java

Module No.	Unit No.	Details	Hrs.	CO
1	**Classes, Objects and Arrays**		06	CO 1
	1.1	Features of Java programming Language, JDK and JVM, Classes Object, Method, Member, Dot Operator, Command Line Argument, Input using Scanner Class, Input using BufferedReader Class		
	1.2	Constructor, Constructor Overloading, Garbage Collection		
	1.3	1D Array, 2D Array, Jagged Array, Array of Objects		
	1.4	Introduction to Manual and Automated Testing, Test case writing, Testing the code		
2	**String Handling and Inheritance**		06	CO 2
	2.1	String Class and Methods, String Buffer Class and Methods		
	2.2	Types of Inheritance, Polymorphism – method overloading, method overriding		
	2.3	Final class and method, Abstract class, Interface		
3	**Exception Handling, Packages and Multithreading**		08	CO 3
	3.1	Types of Exception, try-catch-finally, throw, throws		
	3.2	User Defined Exception		
	3.3	Creating and Using User Defined Package		
	3.4	Introduction to Multithreading, Thread Life Cycle, Creating Threads using Runnable Interface and Thread Class		
4	**Collection Classes and Functional Programming**		06	CO 4
	4.1	Collection classes- ArrayList, Hashset, TreeSet, HaspMap, TreeMap		
	4.2	Introduction to functional programming, lambda expressions, method references, predefined functional interfaces, Streams API		
5	**GUI Programming**		04	CO 4
	5.1	Introduction to GUI Programming, Classes of swing package		
	5.2	Introduction to JDBC, CRUD operation in JDBC		
		Total	30	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Herbert Schildt	*Java: The Complete Reference*	Tata McGraw- Hill Publishing Company Limited	Tenth Edition, 2017
2.	Sachin Malhotra, Saurab Choudhary	*Programming in Java*	Oxford University Press	Second Edition, 2018
3.	D.T. Editorial Services	*Java 8 Programming Black Book*	Dream tech Press	Edition 2015

*** LAB/TUT CA will consist of Experiments performed, written record of experiments, Oral, Onscreen Test, Quiz(s), Presentation(s), assignment(s) etc., based on laboratory work and entire theory syllabus of Programming Laboratory" (216U42L301) with Java Programming.**

Course Code	Course Title			
216U42L301	Object Oriented Programming Laboratory @			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	–	02	02	04
Credits Assigned	–	01	02	03

Examination Scheme	Marks				
	LAB/TUT CA*	CA (TH)		ESE	Total
		IA	ISE		
	75	–	–	–	75

@Advanced Python

Course prerequisites: Basics of Python Programming

Course Objectives:

The objective of this laboratory course is to impart knowledge of using object oriented programming methodology with python, testing python applications, working with multithreading, scientific and mathematical computing, GUI design and database handling based applications using various python libraries.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1. Describe the fundamental principles of object-oriented programming, including classes, objects, inheritance, encapsulation, data hiding and polymorphism.
CO2. Implement object oriented programming principles such as classes and objects, inheritance, and polymorphism to model real-world entities and relationships.
CO3. Demonstrate use of numpy, matplotlib, Pandas and Seaborn libraries for Data Analysis and Data Visualization.
CO4. Design python applications using GUI design, database connectivity and multithreading.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Object-Oriented Programming**		4	CO1
	1.1	Introduction to OOP and its advantages		
	1.2	The Python programming language and its role in OOP		
	1.3	Classes and objects in Python, Basic OOP principles		
	1.4	Introduction to Manual and Automated testing, Test case writing, Testing the code		
2	**Classes, Objects, Inheritance and Polymorphism in Python**		8	CO2
	2.1	Creating and initializing objects, Methods and attributes in classes		
	2.2	Constructor and destructor methods, Class composition and aggregation		
	2.3	Inheritance and its importance, Polymorphism and method overriding		
	2.4	Abstract classes and interfaces, Polymorphic behavior		
3	**Encapsulation and Data Hiding**		4	CO1
	3.1	Data hiding and encapsulation		
	3.2	Public, private, and protected members		
	3.3	Property decorators and getter/setter methods		
	3.4	Advantages and use cases for encapsulation		
4	• **Pandas and Seaborn**		8	CO3
	4.1	Revision of **NumPy** and **Matplotlib**: Summary of NumPy arrays, functions, applications, matplotlib plots and graphs.		
	4.2	**PANDAS**: Series and Dataframes, read /write data frames from/to csv files, json files, excel files		
	4.3	Statistical and Iteration functions: sum (), count (), mean (), median(), mode(), std(), cumsum(), cumprod(), iterrows(), iter_tuples(), describe()		
	4.4	Sorting and Searching: Sort by label, sort by value, Pattern Matching using regex		
	4.5	**SEABORN**: Intro and supported data types		
	4.6	Plots and Charts - I: Line, Bar, Box, Pair, Scatter, Histogram, Pie charts		
	4.7	Types of Plots - II: Regression, Density, Distribution		
5	**GUI design, Database Connectivity and Multithreading**		6	CO4
	5.1	GUI Programming Toolkits, Creating GUI Widgets with Tkinter, Creating Layouts, Form Components, Dialog Boxes, Event creation		
	5.2	Types of Databases Used with Python, Mysql database Connectivity with Python, SQL Relational Databases Connection: Exception handling, Cursor, Row Objects, CRUD operations accomplishment using python, Transactions and Rollbacks		
	5.3	Multithreading in Python, Process vs Thread, Lifecycle of a Thread, Thread Class, Methods of thread object		

Total	**30**	

- Instructor needs to provide additional resources to students for in-depth understanding and practical applicability of the indicated topic/topics.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Steven F. Lott, Dusty Phillips	*Python Object-Oriented Programming: Build robust and maintainable object-oriented Python applications and libraries*	Packt Publishing Limited	4th Edition 2021
2.	Reema Thareja	*Python Programming Using Problem Solving Approach*	Oxford University Press	Second Edition 2023
3.	Wes McKinney	*Python for Data Analysis*	OReilly	3rd Edition
4.	Alberto Boschetti, Luca Massaron	*Python Data Science Essentials*	OReilly	3rd Edition
5.	Albert Lukaszewsk	*MySQL for Python*	Packt Publishing	1st Edition, 2010

*** LAB/TUT CA will consist of Experiments performed, written record of experiments, Oral, Onscreen Test, Quiz(s), Presentation(s), assignment(s) etc., based on laboratory work and entire theory syllabus of Programming Laboratory" (216U42L301) with Advanced Python Programming.**

Course Code	Course Title			
216U42L301	Object Oriented Programming Laboratory @			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	–	02	02	04
Credits Assigned	–	01	02	03

Examination Scheme	Marks				
	LAB/TUT CA*	CA (TH)		ESE	Total
		IA	ISE		
	75	–	–	–	75

@ C++

Course prerequisites: Programming in C

Course Objectives:

The major objective of the course is to introduce the fundamental concept of Object Oriented Programming (OOP) using C++. Students will be able to develop the skills with the comprehensive capabilities that are required for efficient programming. Develop applications for a range of problems using object-oriented programming techniques.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1. Inculcate fundamental concepts of Object Oriented Programming.
CO2. Implement the principles of Data Abstraction Inheritance & Polymorphism.
CO3. Demonstrate the use of templates and standard template library.
CO4. Implement file handling and exception handling.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to C++ fundamentals**		6	CO1
	1.1	Object-Oriented Thinking: Different paradigms for problem solving, need for OOP paradigm, differences between OOP and Procedure oriented programming, Overview of OOP concepts Abstraction, Encapsulation, Inheritance and Polymorphism, C Vs. C++, C++ Basics: I/O in C++		
	1.2	Pointers, Dynamic memory allocation and de-allocation using new and delete		
	1.3	Introduction to Manual and Automated testing, Test case writing, Testing the code		
2	**Classes, Data Abstraction & Operator Overloading**		6	CO2
	2.1	Introduction, Class Scope and accessing Class Members, Separating Interface from Implementation, Controlling Access Function and Utility Functions		
	2.2	Initializing Class Objects: Constructors, Using Default Arguments With Constructors, Using Destructors, Classes : Const(Constant) Object And Const Member Functions, Object as Member of Classes, Friend Function and Friend Classes, Using This Pointer, Pointers to objects, Static Class Members, Function overloading		
	2.3	Fundamentals of Operator Overloading, Restrictions On Operators Overloading, Operator Functions as Class Members vs. as Friend Functions, Overloading, <<, >> Overloading Unary Operators, Overloading Binary Operators.		
3	**Inheritance, Virtual Functions and Polymorphism**		6	CO2
	3.1	Introduction to Inheritance, Base Classes And Derived Classes, Protected Members, Casting Base- Class Pointers to Derived-Class, Using Member Functions, Overriding Base – Class Members in a Derived Class, Public, Protected, and Private Inheritance, Using Constructors and Destructors in derived Classes, Implicit Derived –Class Object To Base Class Object Conversion, Composition Vs. Inheritance		
	3.2	Introduction to Virtual Functions, Abstract Base Classes And Concrete Classes, Polymorphism, Dynamic Binding		
4	● **Templates and Standard Template Library**		6	CO3
	4.1	Templates, function templates and class templates		
	4.2	Overview and use of Standard Template Library, STL classes: list, map, stack, queue		
5	● **File Handling and Exception Handling**		6	CO4
	5.1	Concept of streams, cin and cout objects, C++ stream classes, Unformatted and formatted I/O, manipulators, File stream, C++ File stream classes, File management functions		
	5.2	Basics of C++ Exception Handling: Try Throw, Catch, Throwing an Exception, Catching an Exception, Rethrowing an Exception		
		Total	30	

● Instructor needs to provide additional resources to students for in-depth understanding and

practical applicability of the indicated topic/topics.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	B. Stroutstrup	*The C++ Programming Language*	Pearson Education India	3rd Edition 1 January 2002
2.	E Balagurusamy	*Object oriented Programming with C++*	Tata McGrawHill	8th Edition 24 September 2020
3.	Robert Lafore	*Object Oriented Programming C++*	Pearson Education India	4th edition 1 January 2008
4.	Herbert Schildt	*C++: The Complete Reference*	McGraw Hill Education	4th edition 1 July 2017
5.	Jeff Langr	*Modern C++ Programming with Test-Driven Development : Code Better, Sleep Better*	O′Reilly	1st edition 5th November 2013

*** LAB/TUT CA will consist of Experiments performed, written record of experiments, Oral, Onscreen Test, Quiz(s), Presentation(s), assignment(s) etc., based on laboratory work and entire theory syllabus of Programming Laboratory" (216U42L301) with C++ Programming.**

Course Code	Course Title			
216U42L302	Data Structures Laboratory			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	--	02	--	02
Credits Assigned	--	02	--	01

Examination Scheme	Marks				
	LAB/TUT CA*	CA (TH)		ESE	Total
		IA	ISE		
	50	--	--	--	50

*** LAB/TUT CA will consist of Experiments performed, written record of experiments, Oral, Onscreen Test, Quiz(s), Presentation(s), assignment(s) etc., based on laboratory work and entire theory syllabus of "Data Structures" (216U42C302).**

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216U42L303</td><td colspan="5">Database Management Systems Laboratory</td></tr>
<tr><td></td><td>TH</td><td colspan="2">P</td><td>TUT</td><td>Total</td></tr>
<tr><td>Teaching Scheme (Hrs.)</td><td>--</td><td colspan="2">02</td><td>--</td><td>02</td></tr>
<tr><td>Credits Assigned</td><td>--</td><td colspan="2">01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="3">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td rowspan="2">LAB/TUT CA*</td><td colspan="2">CA (TH)</td><td rowspan="2">ESE</td><td rowspan="2">Total</td></tr>
<tr><td>IA</td><td>ISE</td></tr>
<tr><td>50</td><td>--</td><td>--</td><td>--</td><td>50</td></tr>
</table>

*** LAB/TUT CA will consist of Experiments performed, written record of experiments, Oral, Quiz(s), Presentation(s), assignment(s) etc., based on laboratory work and entire theory syllabus of "Database Management Systems" (216U42C303).**

Course Code	Course Title			
216U42L304	Fundamentals of Data Science Laboratory			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	--	02	--	02
Credits Assigned	--	01	--	01

Examination Scheme	Marks				
	LAB/TUT CA*	CA (TH)		ESE	Total
		IA	ISE		
	50	--	--	--	50

*** LAB/TUT CA will consist of Experiments performed, written record of experiments, Oral, Quiz(s), Presentation(s), assignment(s) etc., based on laboratory work and entire theory syllabus of "Fundamentals of Data Science" (216U42C304).**

Semester IV

SY B. Tech. AI & DS

(KJSCE SVU 2023)

Course Code	Course Title			
216U42C401	Statistics, Probability and Optimisation Techniques			
	TH	P	TUT+	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	LAB/TUT CA*	CA (TH)		ESE	Total
		IA	ISE		
	25	20	30	50	125

+Batch wise Tutorial

Course prerequisites: Basics of Statistics and Probability, Introductory Linear programming problems

Course Objectives:

This course Exposes students to the concepts of Correlation, Regression for given bivariate and multivariate data. Students are made familiar with different discrete and continuous probability distributions. The course acquaints students with concepts of large sample test, Small sample test and Chi – Square test. The course familiarizes students with different methods of solving Linear and Non Linear Programming problems. Using these methods, it will be possible to analyze and interpret a given real life situation and think of possible solutions.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1. Apply concepts of Binomial, Poisson, Exponential and Normal distribution to solve Engineering problems.
CO2. Apply concepts of correlation, regression for given bivariate and multivariate data.
CO3. Estimate population parameters and apply large and small sample test to analyze collected data.
CO4. Apply concepts of Linear and Nonlinear programming methods to solve problems.

Module No.	Unit No.	Details	Hrs.	CO
1	**Probability and Probability Distribution**		12	CO1
	1.1	Review: Probability, Conditional Probability, Bayes' theorem, Joint Probability		
	1.2	Discrete and Continuous Probability Distribution, Expected value and Variance of Random variables		
	1.3	Skewness and Kurtosis, Quantiles		
	1.4	Binomial Distribution, Poisson Distribution		
	1.5	Uniform Distribution, Normal Distribution, Exponential Distribution		
2	**Correlation and Regression**		06	CO2
	2.1	Correlation, Co-variance, Karl Pearson Coefficient of Correlation & Spearman's Rank Correlation Coefficient.		
	2.2	Regression Coefficients, lines of regression, logistic regression.		
	Self-Learning topic: Correlation and regression in Multivariate.			
3	**Estimation Theory**		04	CO3
	3.1	Estimation of Parameters: Central Limit Theorem, point estimation, Unbiased Estimators, Efficiency of Estimators		
	3.2	Estimation of Confidence interval for Mean with known Variance and unknown Variance		
4	**Sampling Theory**		12	CO3
	4.1	Sampling distribution. Test of Hypothesis. Level of significance, critical region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples. p-value		
	4.2	Difference between sample mean and population means for large samples, Test for significance of the difference between the means of two large samples.		
	4.3	Student's t-distribution: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two Samples, paired t-test.		
	4.4	Chi-square distribution as a Test of Independence, Test of the Goodness of fit and Yate's correction.		
	4.5	Fisher's F test, One way and Two way ANOVA tables		
5	**Optimization Techniques**		11	CO4
	5.1	Types of solution, Standard and Canonical form of LPP, Basic and feasible solutions, simplex method.		
	5.2	Artificial variables, Big –M method (method of penalty).		

	5.3	Unconstrained optimization, problems of two or three variables with one equality constraint using Lagrange's Multiplier method.		
	5.4	Problems of two or three variables with one inequality constraint using Kuhn-Tucker conditions		
		Total	**45**	

Recommended Books:

Sr. No.	**Name/s of Author/s**	**Title of Book**	**Name of Publisher with country**	**Edition and Year of Publication**
1	T Veerarajan	*Probability Statistics and Random Processes*	Tata McGraw Hill, India	2nd Edition
2	Erwin Kreyszig	*Advance Engineering Mathematics*	Wiley Eastern Limited, India	10th Edition 2015
3	J. K. Sharma	*Operation research: Theory and Applications*	Laxmi Publications, India	6th Edition 2017
4	Richard A. Johnson	*Probability and Statistics for Engineers*	PHI Learning Private Limited	8th Edition 2011
5	Ronald E.Walipole, Raymond H.Myers	*Probabilities & Statistics for Engineers & Scientists*	Pearson Education	9th Edition 2010

***TUT CA will consist of Tutorials covering entire syllabus of "Statistics, Probability and Optimisation Techniques" (216U42C401). Students will be graded based on continuous assessment of their term work. At least 2 tutorials will be conducted with the help of Mathematical and Statistical software.**

Course Code	Course Title			
216U42C402	Analysis of Algorithms			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	LAB/TUT CA	CA (TH)		ESE	Total
		IA	ISE		
	--	20	30	50	100

Course prerequisites: Data Structures and Programming Language & its concepts.

Course Objectives:

The objective of the course is to introduce the fundamentals of analysis of algorithms. The Specifications and process for algorithm analysis is covered using Advance algorithms. The course helps understanding efficiency of algorithms and comparison of algorithms based on its Efficiency. The course also covers different algorithm design strategies required for research in algorithm domain, along with examples.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1. Analyse basic and divide & conquer strategy based algorithms with its time and space complexity.
CO2. Illustrate greedy and dynamic programming approaches based algorithms.
CO3. Implement advance programming algorithms with its application.
CO4. Understand computability theory concept

Module No.	Unit No.	Details	Hrs.	CO
1	**Analysis of Basic Algorithms**		**08**	**CO1**
	1.1	Selection sort, Insertion sort, Shell sort, Heap sort, Counting Sort, Sorting in Linear Time,		
	1.2	Asymptotic notations and order of growth. Common running times: Linear, quadratic, logarithmic etc. and its examples. Rate of growth of functions, Analysing and Designing Algorithms.		
		#Self-learning topic: Analysis of Radix Sort		
2	**●Analysis of Divide and Conquer Algorithms**		**07**	**CO 1**
	2.1	Divide and Conquer Strategy: Quick sort, randomized Quick sort, Merge sort, Strassen's Matrix Multiplication Algorithm		
	2.2	Recurrence relations, Methods to solve Recurrence: Substitution Method, Recursion tree, Master Theorem Method.		
3	**Greedy Algorithms and Dynamic Programming**		**15**	**CO 2**
	3.1	The Greedy Approach, Dijkstra's algorithm Single Source Shortest Path, Huffman Algorithm, Residual Network, Augmenting Path, Ford-Fulkerson Method Max Flow.		
	3.2	Dynamic Programming and Optimization problems, Longest Common Subsequence, Floyd-Warshall Algorithm for All Pair Shortest Path, Matrix-chain multiplication,		
	3.3	Advance Concepts: Randomized Quick sort, The Hiring Problem, String Matching Algorithm: The Knuth-Morris-Pratt algorithm, Red-Black tree and Augmenting data structures: interval trees		
		#Self-learning topic: Kruskal's & Prims Algorithm, Knapsack Problem using Greedy Approach, , Dynamic Programming, OBST		
4	**Backtracking and Branch and Bound Algorithms**		**9**	**CO 3**
	4.1	The Backtracking Technique, N-Queens Problem, Sum of Subsets Problem,		
	4.2	Branch and Bound Technique, Travelling Salesman Problem, 15 Puzzle Problem		
		#Self-Learning - Hamiltonian Circuit Problems using Backtracking, 0/1 Knapsack using Branch and Bound		
5	**Computability Theory**		**6**	**CO4**
	5.1	P, NP, NP-Hard and NP complete Problems		
	5.2	NP reducibility		
		Total	**45**	

- Instructor needs to provide additional resources to students for in-depth understanding and

practical applicability of the indicated topic/topics.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	T.H. Coreman , C.E. Leiserson,R.L. Rivest, and C. Stein	*Introduction to algorithms*	Prentice Hall India Publication	4th Edition 2022
	Horowitz, Ellis., Sahni, Sartaj	*Fundamentals of Computer Algorithms*	Pitman, India publication.	1978
2.	Richard E. Neapolitan	*Foundation of Algorithms*	Jones & Bartlett Students Edition	5th Edition 2016
3.	Jon Kleinberg, Eva Tardos	*Algorithm Design*	Pearson India Education Services Pvt. Ltd.	10th Edition 2013
4.	Harsh Bhasin	*Algorithms: Design & Analysis*	Oxford Higher education, India	1st Edition 2013
5.	Jeffrey J. McConnell	*Analysis of Algorithms: An Active Learning Approach*	Jones and Bartlett Student Edition	2nd Edition 2017

Course Code	Course Title			
216U42C403	Artificial Intelligence			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	LAB/TUT CA	CA (TH)		ESE	Total
		IA	ISE		
	--	20	30	50	100

Course prerequisites: Mathematics- Probability Theory, Data structure.

Course Objectives:

This course introduces basic principles, techniques, and applications of Artificial Intelligence. The course coverage includes knowledge representation, logic, inference, problem solving, search algorithms, game theory, perception, learning and agent design.
Students will develop familiarity with programming for AI applications.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand structure, types and PEAS parameters of an AI agent.
CO2: Formulate the problem as a state space representation.
CO3: Apply appropriate search algorithm for a given problem.
CO4: Solve problems with logics and reasoning.
CO5: Understand fundamentals of learning in AI.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction**		05	CO 1
	1.1	Introduction to AI, AI Problems and AI techniques		
	1.2	Intelligent agents, Types of Agents		
	1.3	Agent Environments PEAS representation with examples and Task properties for an Agent		
2	**State space and Uninformed search**		10	CO 2, CO 3
	2.1	Problem Formulation and State space representation, Water Jug problem, Vacuum Cleaner world, N- Puzzle, N-Queens, Missionaries and Cannibals		
	2.2	DFS, BFS, Uniform Cost search and Iterative Deepening		
	2.3	Solving problems by searching with examples		
3.	**Informed and Adversarial Search**		10	CO 3
	3.1	Heuristic functions, Best First Search, Greedy BFS, A*		
	3.2	• Local search algorithms and optimization problems, Hill Climbing, Simulated Annealing and Genetic algorithms		
	3.3	Game Playing, Min-Max Search, Alpha Beta pruning		
4	**Knowledge and Reasoning**		12	CO 4
	4.1	A Knowledge Based Agent, Wumpus world Environment, Logic, Propositional Logic, Propositional theorem proving.		
	4.2	Syntax and semantics of first-order logic, propositional vs. First-order inference.		
	4.3	• Forward and Backward Chaining, Resolution		
	4.4	Acting under uncertainty, Basic probability notation, Inference using full joint distributions, Bayes' rule, Bayesian networks and inferences.		
5	• **Learning**		08	CO 5
	5.1	Supervised Learning with examples, ID3 Decision tree		
	5.2	Unsupervised Learning with examples, K-means algorithm		
	5.3	Reinforcement Learning with examples, Q-Learning		
		Total	45	

• Instructor needs to provide additional resources to students for in-depth understanding and practical applicability of the indicated topic/topics.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Stuart Russell and Peter Norvig	*Artificial Intelligence: A Modern Approach*	Pearson, 2010	4th Edition
2.	Elaine Rich and Kevin Knight	*Artificial Intelligence*	Tata McGraw-Hill, 2017.	3rd Edition,
3.	Jason Brownlee.	*Master Machine Learning Algorithms*	eBook, 2017	Edition, v1.12
4.	Patrick H. Winston	*Artificial Intelligence*	Pearson Education, 1997	3rd Edition
5.	Luger, George F	*Artificial intelligence: structures and strategies for complex problem solving*	Pearson Education, 2009	6th Edition

Course Code	Course Title			
216U42C404	Operating Systems			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	LAB/TUT CA	CA (TH)		ESE	Total
		IA	ISE		
	--	20	30	50	100

Course prerequisites: Fundamentals of Computers.

Course Objectives: In this course students understand the basic structure of modern operating system. They studied the process management and Demonstrate use of inter process communication. Also learn I/O management, memory management and file management system. They are also able to demonstrate open source operating systems like Linux.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1: Understand basic structure of Operating System.

CO2: Comprehend process management and inter process communication.

CO3: Enumerate memory management and its policies.

CO4: Identify input/output management and file management policies.

Module No.	Unit No.	Details	Hrs.	CO
1	**Overview of Operating System**		06	CO1
	1.1	**Introduction to OS:** Interaction of OS and hardware, Goals of OS, Basic functions of OS, OS Services, System Calls, Types of system calls.		
	1.2	**Types of OS**: Batch, Multiprogramming, Time sharing, Parallel, Distributed & Real-time OS.		
	1.3	**Structures of OS**: Monolithic, Layered, Virtualization-Virtual Machines, Microkernels		
2	**Process Management**		10	CO2
	2.1	**Processes:** Process Concept, process creation, suspension and termination, Process States: 2, 5, 7 state models, Process Description, Process Control block.		
	2.2	**Threads**: Multithreading models, Thread implementations – user level and kernel level threads, Symmetric Multiprocessing.		
	2.3	**Uniprocessor Scheduling**: Scheduling Criteria, Types of Scheduling: Preemptive, Non-preemptive, Long-term, Medium-term, Short-term schedulers. **Scheduling Algorithms**: FCFS, SJF, SRTF, RR, Priority.		
	2.4	Process Security		
3	**Inter process Communication**		09	CO2
	3.1	**Concurrency**: Issues with concurrency, Principles of Concurrency, critical section and race condition, Pipe and types of pipe.		
	3.2	**Mutual Exclusion**: Hardware and Software approaches, OS/Programming Language support: Semaphores, Mutex and Monitors.		
	3.3	**Classical Problems of Synchronization**: Readers-Writers problem, Producer Consumer problem, Dining Philosopher problem		
	3.4	**Deadlock**: Principles of deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Deadlock Recovery		
4	**Memory Management**		12	CO3
	4.1	**Memory Management concepts:** Memory Management requirements, Memory Partitioning: Fixed, Dynamic Partitioning, Buddy Systems, Fragmentation, Paging, Segmentation, Address translation.		
	4.2	**Placement Strategies**: First Fit, Best Fit, Next Fit and Worst Fit.		
	4.3	**Page Replacement Policies**: FIFO, LRU, Optimal		
5.	**Input Output and File Management**		08	CO4
	5.1	**I/O management:** I/O Devices - Types, Characteristics of devices, OS design issues for I/O management, I/O Buffering.		

	5.2	**Disk scheduling:** Disk scheduling algorithms		
	5.3	**File Management**: Concepts, File Organization and access, File Directories, File Sharing, File allocation, Secondary Storage Management, Free Space management, Security.		
	5.4	• **Windows file system**: FAT, FAT32, NTFS, ReFS		
	5.5	• **Linux file system**: ext-2,3,4, reiserFS, XFS, JFS		
		Total	**45**	

• Instructor needs to provide additional resources to students for in-depth understanding and practical applicability of the indicated topic/topics

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Silberschatz A, Galvin P, Gagne G,	*Operating System Concepts*	Wiley	VIIIth Edition, 2011.
2.	William Stallings,	*Operating Systems: -Internals & Design Principles*	Pearson	VIIth Edition, 2012.
3.	Andrew S. Tanenbaum, Herbert Bos,	*Modern Operating Systems*	Prentice Hall,	IVth Edition, 2014.
4.	D M Dhamdhere	*Operating System Programming and Operating Systems*	Tata McGraw	IInd Revised Edition, 2012
5.	Richard Blum and Christine Bresnahan,	*Linux Command Line & Shell Scripting*	Wiley	IInd Edition edition, 2012.

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Course Code	Course Title			
216U42C405	Computer Networks and Information Security			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	03	--	--	03
Credits Assigned	03	--	--	03

Examination Scheme	Marks				
	LAB/TUT CA	CA (TH)		ESE	Total
		IA	ISE		
	--	20	30	50	100

Course prerequisites: Knowledge of web technologies

Course Objectives: Information is one of the most important organization assets. For an organization, information is valuable and should be appropriately protected. So Information security goals, vulnerabilities, threats and various attacks are covered in this course. Cryptography in digital world offers three core areas that protect us and our data from attempt theft, theft or an unauthorized use of our data and possible fraud. This course describes basics of cryptography, types of cryptography and Hash functions.

Course Outcomes:

At the end of successful completion of the course the student will be able to

The student should be able to

CO1: Understand the data communication systems, network topologies and network devices.
CO2: Enumerate the layers of the TCP/IP model and protocols.
CO3: Describe the basics of Information Security
CO4: Illustrate different cryptographic algorithms for security.
CO5: Understand cryptographic hash functions and network security

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction of Networks**		06	CO 1
	1.1	Data Communications, Networks, The Internet, Protocols and Standards, Uses of Computer networks		
	1.2	Network Models: Layered tasks, The OSI Model, Layers in the OSI Model, TCP/IP Protocol Suite		
2	**Protocols of Application, Transport and Network Layer**		06	CO 2
	2.1	Application layer paradigms: Client Server and Peer to Peer paradigm. Application layer protocols: Domain Name System (DNS), HyperText Transfer Protocol (HTTP), Remote Logging (Telnet), Email (SMTP, MIME, POP3), File Transfer (FTP)		
	2.2	Transport Layer protocols: The Transport Layer Services, Protocols: UDP, TCP		
	2.3	The Network Layer protocols: The IP Protocol, IPv4 Header, ARP and RARP.		
3.	**Introduction to Information Security**		05	CO3
	3.1	Information Security and its goals – CIA.		
	3.2	Threats, Vulnerabilities and Attacks. OSI security architecture: Security Services and Mechanisms. Mapping of goals to security services and mechanisms.		
	3.3	Basics of Cryptography - Shannon's characteristics of good cipher, confusion and diffusion, concepts of encryption, decryption, non-repudiation. Historical background, Classification of ciphers		
4	**Symmetric and Asymmetric key Cryptography**		15	CO4
	4.1	Classical Ciphers - Transposition ciphers - Row transposition, Column transposition and Double transposition cipher, Substitution- Mono-alphabetic Ciphers - shift cipher or additive cipher, multiplicative cipher, affine cipher, Polyalphabetic Ciphers - Playfair, Vignere.		
	4.2	Symmetric key cryptography: concept and applications, Stream Ciphers- A5/1 cipher, Block Ciphers: Festal structure, DES, 3DES, problems with symmetric key cryptography,		

		shared key generation using Diffie-Hellman key exchange protocol,		
	4.3	Asymmetric key cryptography: concept and applications, RSA: Key generation, encryption/decryption, concept of digital signature, problems with asymmetric key cryptography, symmetric key Vs asymmetric key cryptography.		
5	**Cryptographic Hash Functions and Network Security**		**08**	**CO5**
	5.1	Cryptographic Hash Function: Concept, Security Goals and Services provided, Properties, Avalanche Effect, Message Digest, Cryptographic Hash algorithms - MD5 & SHA-1, DES modes and Message Authentication Codes.		
	5.2	TCP/IP vulnerabilities, protocol flaws and attacks - Reconnaissance of network, Social Engineering, ARP Spoofing, IP spoofing, DoS, DDoS. Network security solutions - Firewall and IDS		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1	B. A. Forouzan and Firouz Mosharraf	*Computer Networks A Top down Approach*	Tata McGraw Hill, India	Indian Edition, 2023
2	B. F. Forouzan	*TCP/IP Protocol Suite*	Tata McGraw Hill, India	4th Edition,2017
3	Mark Stamp	*Information Security: Principles and Practice*	Wiley	2nd Edition 2011
4	Behrouz A. Forouzan	*Cryptography and Network Security*	McGraw – Hill	2nd edition 2008
5	William Stallings	*Cryptography and Network Security*	Pearson Education	4th Edition 2014

Course Code	Course Title			
216U42L401	Data Visualization Laboratory			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	--	02	--	02
Credits Assigned	--	01	--	01

Examination Scheme	Marks				
	LAB/TUT CA*	CA (TH)		ESE	Total
		IA	ISE		
	75	--	--	--	75

Course prerequisites: Statistical Knowledge, Basic Understanding of Mathematics, Creativity and Design Skills

Course Objectives:

This course aims to impart a comprehensive understanding of data visualization's significance and practical applications. Students will master popular data visualization tools and techniques, ensuring they can transform complex data into clear, insightful visualizations. They'll also focus on ethical considerations and storytelling, learning how to present data effectively. The course encourages collaboration and critical thinking, equipping students with essential skills for data science and engineering projects. By the end, students will be well-prepared to use data visualization as a powerful tool in making data-driven decisions and communicating insights.

Course Outcomes:

At the end of successful completion of the course the student will be able to

The student should be able to

CO1: Demonstrate a foundational understanding of data visualization concepts and tools

CO2: Apply their knowledge of Data Visualization to create a variety of Interactive Dashboard

CO3: Analyze complex datasets, connect and prepare data in Data Visualization tool, and use advanced visualization techniques.

CO4: Evaluate data visualizations for their effectiveness and apply best practices in data storytelling.

Module No.	Unit No.	Details	Hrs.	CO
1	**Data Visualization with MS Excel**		08	CO1
	1.1	Introduction to data visualization and its importance.		
	1.2	Creating basic charts (bar charts, line charts, pie charts, Scatter Plots) in Excel.		
	1.3	Customizing and formatting Excel charts.		
	1.4	Advanced visualization techniques in Excel, Building Excel dashboards for data insights.		
2	**Data Visualization Tools**		06	CO2
	2.1	Introduction to Data Visualization tools and interfaces		
	2.2	Data connections and data preparation in the Data Visualization tool.		
	2.3	Building interactive worksheets and visualizations.		
	2.4	Implementing filters, sets, and groups in Data Visualization tool, Dashboard creation and interactivity in Data Visualization tool.		
3.	**Advanced Data Visualization**		06	CO2
	3.1	Calculations and expressions in Data Visualization tool.		
	3.2	Parameters and actions for interactivity.		
	3.3	Advanced chart types and mapping in Data Visualization tool.		
	3.4	Real-world data visualization projects with Data Visualization tool		
	3.5	Introduction Immersive Data Visualization		
4	**Geo-spatial Data Visualization**		04	CO3
	4.1	Geographic mapping and spatial analysis in Data Visualization tool.		
	4.2	Data blending and data integration.		
	4.3	Sharing and publishing reports.		
	4.4	Best practices in data visualization.		
5	**Storytelling using Data Visualization**		06	CO 4
	5.1	The art of data storytelling: understanding your audience.		

	5.2	Choosing the right data narrative and structure.		
	5.3	Visualizing data for maximum impact.		
	5.4	Presenting data stories effectively.		
		Total	**30**	

Recommended Books:

Sr. No.	**Name/s of Author/s**	**Title of Book**	**Name of Publisher with country**	**Edition and Year of Publication**
1.	Kieran Healy	*Data Visualization: A Practical Introduction*	No Starch Press, USA	2nd Edition, 2018
2.	Stephanie Evergreen	*Effective Data Visualization: The Definitive Guide to Visualizing Data for Communication*	O'Reilly Media, USA	2nd Edition, 2019
3.	Cole Nussbaumer Knaflic	*Storytelling with Data: A Data Visualization Guide for Business Professionals*	No Starch Press, USA	2nd Edition, 2019
4.	Alberto Cairo	*The Functional Art: An Introduction to Information Graphics and Visualization*	New Riders, USA	2nd Edition, 2013

*** LAB/TUT CA will consist of Experiments performed, written record of experiments, Oral, Onscreen Test, Quiz(s), Presentation(s), assignment(s) etc., based on laboratory work and entire theory syllabus of "Data Visualization Laboratory" (216U42L401).**

Course Code	Course Title			
216U42L402	Analysis of Algorithms Laboratory			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	--	02	--	02
Credits Assigned	--	01	--	01

Examination Scheme	Marks				
	LAB/TUT CA*	CA (TH)		ESE	Total
		IA	ISE		
	50	--	--	--	50

*** LAB/TUT CA will consist of Experiments performed, written record of experiments, Oral, Onscreen Test, Quiz(s), Presentation(s), assignment(s) etc., based on laboratory work and entire theory syllabus of "Analysis of Algorithms" (216U42C402).**

Course Code	Course Title			
216U42L403	Artificial Intelligence Laboratory			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	--	02	--	02
Credits Assigned	--	01	--	01

Examination Scheme	Marks				
	LAB/TUT CA*	CA (TH)		ESE	Total
		IA	ISE		
	50	--	--	--	50

*** LAB/TUT CA will consist of Experiments performed, written record of experiments, Oral, Quiz(s), Presentation(s), assignment(s) etc., based on laboratory work and the entire theory syllabus of "Artificial Intelligence" (216U42C403).**

<table>
<tr><th>Course Code</th><th colspan="5">Course Title</th></tr>
<tr><td>216U42L404</td><td colspan="5">Operating System Laboratory</td></tr>
<tr><td></td><td>TH</td><td colspan="2">P</td><td>TUT</td><td>Total</td></tr>
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<tr><td>Credits Assigned</td><td>--</td><td colspan="2">01</td><td>--</td><td>01</td></tr>
<tr><td rowspan="3">Examination Scheme</td><td colspan="5">Marks</td></tr>
<tr><td rowspan="2">LAB/TUT CA*</td><td colspan="2">CA (TH)</td><td rowspan="2">ESE</td><td rowspan="2">Total</td></tr>
<tr><td>IA</td><td>ISE</td></tr>
<tr><td>50</td><td>--</td><td>--</td><td>--</td><td>50</td></tr>
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*** LAB/TUT CA will consist of Experiments performed, written record of experiments, Oral, Quiz(s), Presentation(s), assignment(s) etc., based on laboratory work and the entire theory syllabus of "Operating System" (216U42C404)**

Course Code	Course Title			
216U42L405	Computer Networks and Information Security Laboratory			
	TH	P	TUT	Total
Teaching Scheme (Hrs.)	--	02	--	02
Credits Assigned	--	01	--	01

Examination Scheme	Marks				
	LAB/TUT CA*	CA (TH)		ESE	Total
		IA	ISE		
	50	--	--	--	50

*** LAB/TUT CA will consist of Experiments performed, written record of experiments, Oral, Quiz(s), Presentation(s), assignment(s) etc., based on laboratory work and the entire theory syllabus of "Computer Networks and Information Security" (216U42C405).**