Koneru Lakshmaiah Education Foundation
(Category -1, Deemed to be University estd. u/s. 3 of the UGC Act, 1956)
Accredited by NAAC as 'A++' ❖Approved by AICTE ❖ ISO 21001:2018 Certified
Campus: Green Fields, Vaddeswaram - 522 302, Guntur District, Andhra Pradesh, INDIA.
Phone No. +91 8645 - 350 200; www.klef.ac.in; www.klef.edu.in; www.kluniversity.in
Admin Off: 29-36-38, Museum Road, Governorpet, Vijayawada - 520 002. Ph: +91 - 866 - 3500122, 2576129

DEPARTMENT OF MATHEMATICS

PROGRAM DEVELOPMENT DOCUMENT

M.Sc.(Computational Mathematics)

2024-25

Vision of University: To be a globally renowned university.

Mission of University: To impart quality higher education and to undertake research and extension with emphasis on application and innovation that cater to the emerging societal needs through all-round development of students of all sections enabling them to be globally competitive and socially responsible citizens with intrinsic values.

Vision of Department: Department of Mathematics strives to be internationally recognised for academic excellence.

Mission of Department: To provide an environment where the students can learn and become competent users of Mathematics and Mathematical application also to emerge as a global centre of learning, academic excellence and innovative research.

Mission statements:

M1: To create an ambience of Mathematical thinking and applying the same to solve complex engineering problems.

M2: To Develop Mathematical model to solve problems at global level.

M3: To collaborate with other campus entities, individuals, professional associations and local community organizations.

Academic Goals:

G1: To offer academic flexibility by means of Choice Based Credit Systems and the like.

G2: To identify and introduce new specializations and offer programs in emerging areas therein.

G3: To incorporate into the curriculum the Application orientation and use high standards of competence for academic delivery.

G4: To design and implement educational system adhering to outcome based International models.

G5: To introduce and implement innovation in teaching and learning process to strengthen academic delivery.

G6: To offer an academic program at UG, PG, doctoral, Post-Doctoral which is industry focused, and incorporates Trans-discipline, inter-discipline aspects of the education system.

G7: To deliver higher education that includes technologies and meeting the global requirements.

Program Educational Objectives (PEOs):

The Program Educational Objectives (PEOs) are as follows:

PEO-1: Apply mathematics and technology tools (MATLAB) to solve problems.

PEO-2: Understand the use of mathematical tools and concepts in other fields.

PEO-3: Communicate, and work, with people of diverse backgrounds in individual and group settings, in an ethical and professional manner.

PEO-4: Critically analyze information and concepts to adapt to advances in knowledge and technology in the workplace.

Program Outcomes (POs):

PO 1: To identify, formulate, abstract and analyze complex, real life or engineering problems using the principles of mathematical techniques.

PO 2: To apply the mathematical concepts in the fields of high end research and recognize their need and prepare for lifelong learning.

PO 3: To apply mathematics tools (MATLAB, R, and MINITAB) for a better decision making in complex situations.

PO 4: To maintain the core of mathematical and technical knowledge which is adaptable for solid foundation for lifelong learning.

PO 5: To apply ethical principles of mathematical techniques for the commitment of professional ethics, responsibilities and socio-economic needs of the society.

PO 6: Ability to do interdisciplinary research among allied subjects related to applied mathematics.

PO 7: Use symbolic and numerical software as part of practical computation.

MAPPING OF ACADEMIC GOALS WITH MISSION STATEMENTS:

Academic	Mission Statements

Goals	M1	M2	M3	
G1			√	
G2			√	
G3	√			
G4			√	
G5		√		
G6		√	√	
G7			√	

MAPPING OF PEO's with ACADEMIC GOALS:

PEOs	Academic Goals						
	G1	G2	G3	G4	G5	G6	G7
PEO1				√	√		√
PEO2		√				√	√
PEO3				√	√		
PEO4	√	√	√			√	

Mapping of PEOs with Mission Statements of the Department:

S.No	Description of PEOs	Key Components of Mission		
		M 1	M 2	M 3
		To create an ambience of mathematical thinking and applying the same to solve complex engineering problems.	To develop mathematical mode to solve problems at global level.	To collaborate with other campus entities, individuals, professional associations and local community organizations.
PEO 1	Apply mathematics and technology tools (MATLAB) to solve problems.	.✓.		.

PEO 2	Understand the use of mathematical tools and concepts in other fields.			✓
PEO 3	Communicate, and work, with people of diverse backgrounds in individual and group settings, in an ethical and professional manner.			✓
PEO 4	Critically analyze information and concepts to adapt to advances in knowledge and technology in the workplace	✓	✓	

MAPPING OF POs/PSOs with PEOs:

S.No.	Key Components of POs and PSOs	Description of PEO			
		Apply mathematics and technology tools (MATLAB) to solve problems.	Understand the use of mathematical tools and concepts in other fields.	Communicate, and work, with people of diverse backgrounds in individual and group settings, in an ethical and professional manner.	Critically analyze information and concepts to adapt to advances in knowledge and technology in the workplace
		PEO 1	**PEO 2**	**PEO 3**	**PEO 4**
PO1	To identify, formulate, abstract and analyze complex, real life or engineering problems using the principles of mathematical techniques.	✓	✓		✓
PO2	To apply the mathematical concepts in the fields of high end research and recognize their need and prepare for life long learning.	✓	✓	✓	✓

PO3	To apply mathematics tools (MATLAB, R, and MINITAB) for a better decision making in complex situations.	✓	✓		✓
PO4	To maintain the core of mathematical and technical knowledge which is adaptable for solid foundation for life long learning.	✓	✓		✓
PO5	To apply ethical principles of mathematical techniques for the commitment of professional ethics, responsibilities and socio-economic needs of the society.		✓	✓	
PO6	Ability to do interdisciplinary research among allied subjects related to applied mathematics.		✓		✓
PO7	Use symbolic and numerical software as part of practical computation.	✓			✓

Thrust areas of M.Sc. (Computational Mathematics)			
LOCAL	**REGIONAL**	**NATIONAL**	**GLOBAL**
(APIIC)	**(APIIC &*Industry Policy-***	***(CII, NSDC)***	***(World Economic Forum)***

	***Telangana*)**		
Teaching Profession	Teaching Profession	Teaching Profession	Teaching Profession
I.T.Industry	I.T.Industry	I.T.Industry	I.T.Industry
		Industrial_Data Analyst	**Industrial_Data Analyst**
https://apindustries.gov.in/incentives/Data/APIndustrial_Policy_Brochure.pdf	http://industries.telangana.gov.in/Library/Industries%20Policy%20Book%202015.pdf	**https://www.cii.in/PublicationDetail.aspx?enc=EybQ0l0ZfuOvvjXhsIi6HufXCGQ0P2eeL5OV8RB+1l0rIhqmDemCge6V5b1Dlacjo8566Ln57lacL9TgMOjIUmOZOi6Jr5TNtAoon0xFCfmwhuaMecXQQOIrqpZyDMP2FnxdXCR3LPk+qb+GfgfX9vgAnD6+W8FSrQ2lSgF545XgyQTMwEP/zp5UQKwidAVU**	**https://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf**
https://www.rgukt.in/pdfdoc/GO142019HigherEducationDeptGovtofAP.pdf	https://www.aicte-india.org/downloads/reg-paydiploma_220110.pdf	https://www.aicte-india.org/downloads/reg-paydiploma_220110.pdf	https://www.aicte-india.org/downloads/reg-paydiploma_220110.pdf

Mapping of Needs with Mission Statements:

Local, Regional, National and Global Needs		**Mission Statements**			
		M1	**M2**	**M3**	
Local Needs	Teaching Profession	√	√		
	I.T.Industry	√	√		
Regional	Teaching Profession	√	√		

Needs	I.T.Industry	√	√		
National Needs	Teaching Profession	√	√	√	
	I.T.Industry	√	√	√	
	Industrial Data Analyst	√	√	√	
Global Needs	Teaching Profession	√	√	√	
	I.T.Industry	√	√	√	
	Industrial Data Analyst	√	√	√	

Course Outcomes (COs) introduced / Revised in 2024-25 Curriculum as per Local, Regional, National and Global Needs:

Local, Regional, National and Global Needs		Course Outcome (CO)	Course Title
Local Needs	Teaching Profession	CO1: Describe group, subgroup and quotient groups and their applications.	24CT5101-Linear Algebra
		CO2: Demonstrate the concepts of homomorphism and automorphisim of groups.	
		CO3: Illustrate the theory of rings and its applications.	
		CO4: Illustrate the concept of fields and polynomial rings.	
		CO 1: Apply different methods to find the optimal solution of linear programming problems and analyze the sensitivity of the solution.	24CT6102-Mathematical Programming
		CO 2: Different methods to find the optimal solution of Transportation and Assignment problems.	
		CO 3: Apply non-linear optimization methods to solve non- linear programming problems.	
		CO 4: Apply Search methods to solve non-linear programming problems.	
	I.T.Industry	CO 1: Understand the concepts of grammar to improve communication, reading, and writing skills.	24UC5201-Communication Skills
		CO 2: Demonstrate required knowledge over Dos and Don'ts of speaking in the corporate context. Demonstrate ability to face formal situations / interactions.	
		CO 3: Understand the varieties of reading and comprehend the tone and style of the author. Skim and scan effectively and appreciate rhetorical devices.	
		CO 4: Apply the concepts of writing to draft corporate letters, emails, and memos.	
		CO 1: Describe the basic computer organization and concepts of computer language fundamentals.	24CT5105-Computational Thinking for Structured Design Through C++
		CO 2: Apply the concept of user define functions in C++ for modular programming.	
		CO 3: Illustrate user defined C++ functions and different operations on list of data.	
		CO 4: Demonstrate the Object Oriented Concepts and implement linear data structures.	
		CO 5: Develop the code for the algorithms in C++.	
Regional Needs	Teaching Profession	CO 1: Illustrate the functional components of DBMS, importance of data modelling in design of a database.	24CT5102-Relational Algebra and Database

		CO 2: Build queries using SQL and concepts of PL/SQL.	Management System
		CO 3: Apply normalization techniques and indexing to construct and access decent Database.	
		CO 4: Identify the importance of transaction processing, concurrency control and recovery techniques.	
		CO 5: Develop a good database and define SQL queries for data analysis	
	I.T. Industry	CO 1: Illustrate research objects, steps involved in research and articulate appropriate research questions	24IE5201- Essential of Research Design
		CO 2: Perform literature review in a scholarly style and apply appropriate methods for data collection.	
		CO 3: represent the data in tabular or graphical form and prepare data for analysis.	
		CO 4; Perform statistical modelling and analysis to optimize the data , prepare the data for publishing.	
		CO 1: Analyze and compare stack ADT and queue. ADT implementations using linked list and applications.	24CT5201- Data Structures and Algorithms
		CO2: Analyze the linked lists and types of binary trees and their representations.	
		CO3: Analyze different Sorting Algorithms, linked implementation of Binary, Balanced Trees and different Hashing techniques.	
		CO4: Analyze different representations, traversals, applications of graphs and Heap organization.	
		CO5: Develop and evaluate common practical applications for linear and non-linear data structures.	
		CO1: Identify the difference between solutions of system linear and roots of non-linear equations by direct, bisection methods.	24CT5104- Mathematical Modelling & Numerical Methods using MATLAB
		CO2: Construct the interpolation forward and backward tables and find the eigen values and vectors by using MATLAB.	
		CO3: Apply numerical differentiation and integration techniques to a variety of problems by different methods and find the values and compare the values by using MATLAB.	
		CO4: Construct numerical solutions of first and second order ordinary differential equations and compare the numerical values by using MATLAB.	
		CO 5: Verify the solution of the numerical methods through MATLAB.	
National Needs	Teaching Profession	CO1: Describe the concept of Markov process and Poisson Process.	24CT5110- Stochastic Processes & Optimization
		CO2: Illustrate Queuing models and demonstrate the concepts of Brownian motions with applications.	

		CO3: Formulate and solve the LPP. Model and solve Transportation and Assignment problems.	
		CO4: Apply Geometric programming and Ant-colony Optimization and PSO. Solve decision making techniques to solve real life problems.	
		CO1: Understand the basic functions in R programming and identify the operators using in it.	24CT5202-Probability and Statistics
		CO2: Simulating data using R.	
		CO3: Apply various probability distributions to the real world problems using R.	
		CO4: Analyze the data using various linear and nonlinear programming using R.	
		CO5: Apply R-Programming to various data sets	
	I.T.Industry	CO1: Analyze and compare stack ADT and queue ADT implementations using linked list and applications.	24CT5201-Data Structures and Design of Algorithms
		CO2: Analyze the linked lists and types of Binary trees and their representations.	
		CO3: Analyze different Sorting Algorithms, linked implementation of Binary, Balanced Trees and different Hashing techniques.	
		CO4: Analyze different representations, traversals, applications of Graphs and Heap organization.	
		CO5: Develop and Evaluate common practical applications for linear and non-linear data structures.	
		CO1: Able to understand Deep learning and remember the concepts of Perception, Back Propagation,	24CT6105-Deep Learning Concepts
		CO2: Able to understand auto encoders- and apply Regularization, and CNN techniques to generate Deep learning models	
		CO3: Apply Long Short Term Memory (LSTM)	
		CO4: Build Markov models, Markov networks, Markov chains,	
		CO5: Implement basic Neural Networks, optimization algorithms	
	Industrial Data Analyst	CO1: Understand the modelling of various types of data	24CT5204-Data Science &

		CO2: Understand the Visualization fundamentals	Visualization
		CO3: Apply methods and tools for Non-Spatial DataVisualization	
		CO4: Apply methods for Scientific / Spatial Data Visualization and Web data visualization	
		CO5: Evaluate data visualization through Python &Tableau.	
		CO1: Understand the concepts of big data, Initial exploration of analysis of data and Data visualization	24CT6107-Introduction to Big Data Analytics
		CO2: Understand Initial exploration of data and advanced data analytics by using R	
		CO3: Apply advanced algorithms & Statistical modeling for big data using HDFS, HIVE, and PIG.	
		CO4: Apply advanced SQL functions for in-database analytics by MADlib, Greenplum along with common deliverables of analytics life cycle project	
		CO5: Build and Evaluate the Big Data Analytical problem using R, Hadoop, HIVE Programming concepts.	
		CO1: Understand cognitive computing is, and how it differs from traditional approaches	24CT6108-Cognitive Computing
		CO2: Applying the primary tools associated with cognitive Computing	
		CO3: Develop a project that leverages cognitive computing	
		CO4: Analyse and discuss the business implications of cognitive computing	
		CO5: able to implement cognitive computing programs using IBM Watson	
		CO1: Understand the principles of cryptography by analyzing various attacks and apply different classic encryption techniques.	24CT6106-Crypt Analysis & Cyber Defence
		CO2: Understand the principles of block cipher and apply algorithmslike DES, AES.	
		CO3: Understand and apply different algorithms of public key crypto system for ensuring secured communication and authentication.	
		CO4: Understand the concept of elliptic curve and its applications to cryptography. Apply hash algorithms for security.	
		CO5: Implement various cryptographic algorithms so as to analyzethe achievability of security goals	

		like Confidentiality, integrity, authentication and also Justify the possibility of cryptanalysis attack with each algorithm.	
Global Needs	Teaching Profession	CO1: Describe the concept of Markov process and Poisson Process.	24CT5110-Stochastic Processes & Optimization
		CO2: Illustrate Queueing models and Demonstrate the concepts of Brownian motions and applications	
		CO3:Formulate LPP and solve LPP. Model and solve Transportation and Assignment problems	
		CO4:Apply Geometric programming and Ant-colony Optimization and PSO. Solve decision making techniques to solve real life problems	
	I.T.Industry	CO1:Able to understand Deep learning and remember the concepts of Perception, Back Propagation,	24CT6105-Deep Learning Concepts
		CO2:Able to understand auto encoders- and apply Regularization, and CNN techniques to generate Deep learning models.	
		CO3: Apply Long Short Term Memory (LSTM).	
		CO4:Build Markov models, Markov networks, Markov chains,	
		CO5: Implement basic Neural Networks, optimization algorithms	
	Industrial Data Analyst	CO1:Apply error detection and correction mechanisms to compute code words for the source code and outline the working of OSI & TCP/IP reference models.	24CT5206-Cryptography & Security
		CO2:Infer Channel allocation problem and algorithms to avoid it and compute the optimal path in a network using various static and dynamic routing algorithms.	
		CO3: Identify the IP addresses of a network using IPV4 classful & classless addressing schemes and outline the functionalities of the transport layer like TCP connection management and congestion control.	
		CO4:Apply different symmetric and asymmetric encryption algorithms to compute cipher text and identify the functionality of application layer protocols.	
		CO1: Understand the concepts of big data, initial exploration of analysis of data and data visualization.	24CT6107-Introduction to Big

		CO2: Understand initial exploration of data and advanced data analytics by using R.	Data Analytics
		CO3: Apply advanced algorithms & Statistical modeling for big data using HDFS, HIVE, and PIG.	
		CO4: Apply advanced SQL functions for in-database analytics by MAD lib, Green plum along with common deliverables of analytics life cycle project.	
		CO5: Build and evaluate the Big Data Analytical problem using R, Hadoop, HIVE Programming concepts.	
		CO1: Understand cognitive computing is, and how it differs from traditional approaches.	24CT6108-Cognitive Computing
		CO2: Applying the primary tools associated with cognitive Computing.	
		CO3: Develop a project that leverages cognitive computing.	
		CO4: Analyse and discuss the business implications of cognitive computing.	
		CO5: Aable to implement cognitive computing programs using IBM Watson.	
		CO1: Understand the principles of cryptography by analyzing various attacks and apply different classic encryption techniques.	24CT6106-Crypt Analysis & Cyber Defence
		CO2: Understand the principles of block cipher and apply algorithms like DES, AES.	
		CO3: Understand and apply different algorithms of public key crypto system for ensuring secured communication and authentication.	
		CO4: Understand the concept of elliptic curve and its applications to cryptography. Apply hash algorithms for security.	
		CO5:Implement various cryptographic algorithms so as to analyzethe achievability of security goals like Confidentiality, integrity, authentication and also Justify the possibility of cryptanalysis attack with each algorithm.	
		CO1: Analyze and compare stack ADT and queue ADT implementations using linked list and applications.	24CT5201-Data Structures and Design of Algorithms
		CO2: Analyze the linked lists and types of Binary trees and their representations.	

		CO3: Analyze different Sorting Algorithms, linked implementation of Binary, Balanced Trees and different Hashing techniques.	
		CO4: Analyze different representations, traversals, applications of Graphs and Heap organization.	
		CO5: Develop and evaluate common practical applications for linear and non-linear data structures.	

Distribution of Credits

Departments are required to highlight the distribution of credits across the various course categories:

Sl No	Course Category	Short Name	No. of courses	Minimum Credits	Contact Hours	As per AICTE/Any other body Credits	As per ABET Credit Hours(if applicable)
1	Humanities & Social Sciences	HSS	0	-	-	-	-
2	Basic Sciences	BS	0	-	-	-	-
3	Engineering Sciences	ES	-	-			
4	Professional Core	PC	10	39			
5	Flexi Core	FC	-	-			
6	Professional Electives	PE	12	36			
7	Project Courses	PR	3	22			
8	Open Electives	OE	2	6			
Total			**27**	**103**			

Program Structure

Detailed structure of the program highlighting all the courses and their credits:

A.Y._ 2024-25_Batch_M.Sc.(Computational Mathematics)_Structure

SL NO	CAT	Course Code	COURSE TITLE	SNAME	L	T	P	S	I	N	Cr	CH	Pre Prequisites	New Course/ Revised /Retained Coirse	Changes Proposed By	Focused on Employabiloity/Enterpreneurship/Skill	Justification (Detailed justification on how the course content maps to employability/entrepreneurship/skill category.)
1	AUC	24UC5201	Professional Communication Skills	PCS	0	0	4	0	0	0	0	4	NIL	Retained		Skill Development	To enhance the communication skills
2	PCC	24CT5101	Linear Algebra	LA	2	2	0	0	0	0	4	4	NIL	Retained		Employability	To provide employability skills
3	PCC	24CT5102	Relational Algebra and Database Management System	RADMS	2	0	2	4	0	0	4	8	NIL	Retained		Employability	To provide employability skills
4	PCC	24CT5103	Applied Discrete structures	DS	2	2	0	0	0	0	4	4	NIL	Retained		Employability	To provide employability skills
5	PCC	24CT5104	Mathematical Modelling & Numerical Methods using MATLAB	MMNM	2	0	2	0	0	0	3	4	NIL	Retained		Employability	To provide employability skills
6	PCC	24CT5105	Computational Thinking for Structured Design THROUGH C++	CTSD	2	0	2	4	0	0	4	8	NIL	Retained		Employability	To provide employability skills
7	PCC	24CT5201	Data Structures and Design of Algorithms	DS&DA	2	0	2	4	0	0	4	8	CTSD	Retained		Employability	To provide employability skills
8	PCC	24CT5202	Probability and Statistics	PS	2	0	2	4	0	0	4	8	NIL	Retained		Employability	To provide employability skills
9	PCC	24CT5203	Matrix Computation	MC	2	0	2	4	0	0	4	8	LA	Retained		Employability	To provide employability skills

10	PRI	24IE5201	Essentials of Research Design	ERD	2	0	2	0	0	0	3	4	NIL	Retained		Employability	To provide employability skills
11	PCC	24CT6102	Mathematical Programming	MP	2	2	0	0	0	0	4	4	DS	Retained		Employability	To provide employability skills
12	PCC	24CT6103	Transform Techniques for Engineering	TTE	2	2	0	0	0	0	4	4	LA	Retained		Employability	To provide employability skills
13	VAC	24UC6103	VALUE ADDED COURSE 1	IKS	0	0	0	0	0	0	0	0	NIL	Retained		Employability	To provide employability skills
14	PRI	24CT6101	Minor Project	MIP	0	0	4	4	0	0	3	8	ERD, MMNM	Retained		Employability	To provide employability skills
15	OEC		OPEN ELECTIVE - 1	OE-1	3	0	0	0	0	0	3	3	NIL	Retained		Employability	To provide employability skills
16	OEC		OPEN ELECTIVE - 2	OE-2	3	0	0	0	0	0	3	3	NIL	Retained		Employability	To provide employability skills
17	PRI	24CT6201	Major Project	MAP	0	0	24	16	0	0	16	40	SPO, TTE, MIP, CTSD	Retained		Employability	To provide employability skills
			PE-1														
18	PEC	24CT5204	Data Science & Visualization	DSV	2	0	2	0	0	0	3	8	RADMS	Retained		Employability/Enterpreneurship	To provide Enterpreneurship skills

19		24CT5205	Essentials of Machine Learning	ML	2	0	2	0	0	0	3	4	LA, DS	Retained		Employability/Enterpreneurship	To provide Enterpreneurship skills
20		24CT5206	Cryptography & Security	ISC	2	0	2	0	0	0	3	4	LA	Retained		Employability/Enterpreneurship	To provide Enterpreneurship skills
			PE-2														
21	PEC	24CT6104	Data Warehousing & Data Mining	DWM	2	0	2	0	0	0	3	4	DSV	Retained		Employability/Enterpreneurship	To provide Enterpreneurship skills
22		24CT6105	Deep Learning Concepts	DL	2	0	2	0	0	0	3	4	ML	Retained		Employability/Enterpreneurship	To provide Enterpreneurship skills
23		24CT6106	Crypt Analysis & Cyber Defence	CACD	2	0	2	0	0	0	3	4	ISC	Retained		Employability/Enterpreneurship	To provide Enterpreneurship skills
			PE-3														
24	PEC	24CT6107	Introduction to Big Data Analytics	BDA	2	0	2	0	0	0	3	4	DSV	Retained		Employability/Enterpreneurship	To provide Enterpreneurship skills
25		24CT6108	Cognitive Computing	CC	2	0	2	0	0	0	3	4	ML	Retained		Employability/Enterpreneurship	To provide Enterpreneurship skills
26		24CT6109	Introduction to Blockchain & Cryptocurrencies	CACD	2	0	2	0	0	0	3	4	ISC	Retained		Employability/Enterpreneurship	To provide Enterpreneurship skills
		Flexi Core Courses															

27	1	24CT6110	Stochastic Processes & Optimization	SPO	2	2	0	0	0	0	4	4	P&S	Retained		Employability	To provide employability skills
28	2	24CT6111	Quantum Computing	QC	2	2	0	0	0	0	4	4	MMNM	Retained		Employability	To provide employability skills
29	3	24CT6112	Applied Geometry & Computer Graphics	AGCG	2	2	0	0	0	0	4	4	DS	Retained		Employability	To provide employability skills

Percentage of Syllabus Revision= (Total Number of New Courses+ Total Number of Revised Courses) / Total number of Courses.= 0 %

Percentage of Courses focusing on Employability= No. of courses focusing on Employability/ Total number of courses = 96.55%

Percentage of Courses focusing on Entrepreneurship= No. of courses focusing on Entrepreneurship / Total number of courses= 31.03%

Percentage of Courses focusing on Skill Development or Carrere advancement= No. of courses focusing on Skill Development / Total number of courses = 3.44%

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES (POs) and PROGRAM SPECIFIC OUTCOMES (PSOs)

S.No.	Course Code	Course Title	LTPS	Credits	CO NO	Description of the Course Outcome	Program Outcomes							
							1	2	3	4	5	6	7	8
1	24CT5101	Linear Algebra	2-2-0-0	4	CO1	Describe group, subgroup and quotient groups and their applications.		2						
					CO2	Demonstrate the concepts of homomorphism and automorphisim of groups.		2						
					CO3	Illustrate the theory of rings and its applications.		2						
					CO4	Illustrate the concept of fields and Polynomial Rings.		2						
2	24CT5102	Relational Algebra and Database Management System	2-0-2-4	4	CO1	Illustrate the functional components of DBMS, importance of data modeling in design of a database.	1				5			
					CO2	Build queries using SQL and concepts of PL/SQL	1							
					CO3	Apply normalization techniques and indexing to construct and access decent database.					5			
					CO4	Identify the importance of transaction processing, concurrency control and recovery techniques		1						
					CO5	Develop a good database and define SQL queries for data analysis			3					

3	24CT5103	Applied Discrete Mathematics	2-2-0-0	4	CO1	Describe the rules of Propositional logic to the arguments of the statements.						6		
					CO2	Illustrate the concept of discrete structures to represent Boolean functions.						6		
					CO3	Construct recurrence relations and solve them.						6		
					CO4	Apply concepts of graph theory for real life problems.						6		
4	24CT5104	Mathematical Modelling & Numerical Methods using MATLAB	2-0-2-0	3	CO1	Identify the difference between solutions of system linear and roots of non-linear equations by direct, bisection methods.		2	3					
					CO2	Construct the interpolation forward and backward tables and find the Eigen values and vectors by using mat lab also.	1	2						
					CO3	Apply Numerical differentiation and integration problems for different methods and find the values and compare the values by using mat lab also.		2						
					CO4	Construct numerical solutions of first and second order ordinary differential equations and compare the numerical values with mat lab also.		2						
					CO5	Verify the solution of the N.M. through MATLAB.	1							
5	24CT5105	Computational Thinking for	2-0-2-4	4	CO1	Describe the basic computer organization and concepts of computer language fundamentals.							7	

		Structured Design THROUGH C++			CO2	Apply the concept of user define functions in C++ for modular programming.							7		
					CO3	Illustrate user defined C++ functions and different operations on list of data.							7		
					CO4	Demonstrate the Object Oriented Concepts and implement linear data structures.							7		
					CO5	Develop the code for the algorithms in C++							7		
6	24CT5201	Data Structures and Design of Algorithms	2-0-2-4	4	CO1	Analyze and compare stack ADT and queue ADT implementations using linked list and applications.						7			
					CO2	Analyze the linked lists and types of Binary trees and their representations.						7			
					CO3	Analyze different Sorting Algorithms, linked implementation of Binary, Balanced Trees and different Hashing techniques.						7			
					CO4	Analyze different representations, traversals, applications of Graphs and Heap organization.						7			
					CO5	Develop and Evaluate common practical applications for linear and non-linear data structures.						7			
7	24CT5202	Probability and Statistics	2-0-2-4	4	CO1	Understand the basic functions in R programming and identify the operators using in it.	1								
					CO2	Simulating data using R		2							
					CO3	Apply various probability distributions to the real world problems using R	1								
					CO4	Analyze the data using various linear and nonlinear lines using R		2							

					CO5	Apply R-Programming to various data sets			3						
8	24CT5203	Matrix Computation	2-0-2-4	4	CO 1	Use sophisticated scientific computing and visualization environments to solve application problems involving matrix computation algorithms and Explain the effects of errors in computation and how such errors affect solutions.	1	2							
					CO 2	Analyze numerical algorithms, and understand the relationships between the computational effort and the accuracy of these algorithms.	1	2							
					CO 3	CO3 Interpret the results produced by computer implementations of numerical algorithms.			3	4					
					CO 4	Apply Rayleigh quotient iterations and Explicit and implicit QR algorithms..					5	6			
					CO5	Demonstrate the necessary analytical background for further studies leading to research in Machine Learning					5	6			
9	24CT6102	Mathematical Programming	2-2-0-0	4	CO 1	Apply different methods to find the optimal solution of linear programming problems and analyze the sensitivity of the solution.			3						
					CO 2	Different methods to find the optimal solution of Transportation and Assignment problems.			3						
					CO 3	Apply non-linear optimization methods to solve non- linear programming problems			3						
					CO 4	Apply Search methods to solve non-linear programming problems			3						
10	24CT6103	Transform Techniques for Engineering		4	CO 1	Apply Laplace transform techniques to solve linear differential equations in system analysis where initial conditions can be easily included to give system response.	1		3	4					

					CO 2	Applying z- transform and Mellin transform to the analysis and characterization of Discrete Time systems.	1		3					
					CO 3	Apply Fourier series to analyze various signals.				4				
					CO 4	Apply Fourier transforms to analyze various signals.						6		
					CO 5	Verify the solution of the Transform techniques through MATLAB.								
11	24IE5201	Essentials of Research Design	3-0-2-0	4	CO1	Illustrate research objects, steps involved in research and articulate appropriate research questions	1							
					CO2	Perform literature review in a scholarly style and apply appropriate methods for data collection.	1	2						
					CO3	Represent the data in tabular or graphical form and prepare data for analysis.	1							
					CO4	Perform statistical modelling and analysis to optimize the data , prepare the data for publishing.	1	2						
12	24CT5110	Stochastic Processes & Optimization	2-2-0-0	4	CO1	Describe the concept of Markov process and Poisson Process.	1							
					CO2	Illustrate Queueing models and Demonstrate the concepts of Brownian motions and applications						6		
					CO3	Formulate LPP and solve LPP. Model and solve Transportation and Assignment problems.						6		
					CO4	Apply Geometric programming and Ant-colony Optimization and PSO. Solve decision making techniques to solve real life problems.						6		
13	24CT5111	Quantum Computing	2-2-0-0	1	CO1	To introduce basics of quantum computing		2						

					CO2	Implementing Quantum computing algorithms			3						
					CO3	Applying concepts of Quantum computing using QISKIT			3						
					CO4	.Analyze and Discuss Quantum Machine learning and deep learning concepts with applications			3						
					CO5	Practicals on all algorithms discussed above			3						
14	24CT5112	Applied Geometry & Computer Graphics	3-0-2-0	1	CO1	To understand Basics of Augmented Reality and Interactions. Fundamentals of Augmented , Mixed Reality and its features	1								
					CO2	To understand Basics of Virtual Reality and Interactions. Fundamental Concept and Components of Virtual Reality	1				5				
					CO3	To understand Graphics Pipelines, Creating a sampleaugmented reality apps in android	1				5				
					CO4	To apply Unity development Environment, IDE Basics, Sprites, User Interfaces, Simple 3D animation Creation					5				
					CO5	Develop applications through Lab experiments	1				5				
15	24CT6101	Minor Project	0-0-4-4	3											
16	24CT6201	Major Project	0-0-24-16	16											
1	24CT5204	Data Science & Visualization	2-0-2-0	3	CO1	Understand the modelling of various types of data					3				
					CO2	Understand the Visualization fundamentals					2				
					CO3	Apply methods and tools for Non-Spatial Data					5				

						Visualization								
					CO4	Apply methods for Scientific / Spatial Data Visualization and Web data visualization					5			
					CO 5	Evaluate data visualization through Python & Tableau.					5			
2	24CT5205	Essentials of Machine Learning	2-0-2-0	3	CCO1	Understand the basic terminology and measurements of Machine Learning and Apply Machine Learning techniques using Tree and Bayesian models.			3					
					CCO2	Apply and analyze Neural Network and SVM Models for solving Classification and Prediction problems				4				
					CCO3	Apply Dimensionality reduction methods, Evolutionary learning and Ensembles methods to solve classificationproblems			3					
					CO 4	Illustrate different unsupervised models, Analytical, Explanation-Based and reinforcement learning methods		2						
					CO 5	Implement Machine Learning Techniques using PythonLanguage		2			5			
3	24CT5206	Cryptography & Security	2-0-2-0	3	CO 1	Apply error detection and correction mechanisms to compute code words for the source code and outline the working of OSI & TCP/IP reference models.	1	2						
					CO 2	Infer Channel allocation problem and algorithms to avoid it and compute the optimal path in a network using various static and dynamic routing algorithms.	1							
					CO 3	Identify the IP addresses of a network using IPV4 classful & classless addressing schemes and outline the functionalities of the transport layer like TCP Connection management and congestion control.	1	2						

					CO 4	Apply different symmetric and asymmetric encryption algorithms to compute cipher text and identify the functionality of application layerprotocols.	1	2						
1	24CT6104	Data Warehousing & Data Mining	2-0-2-0	3	CO1	Understand Data Warehousing Techniques and apply differentdata processing techniques.	1	2						
					CO2	Implementation of Data Pre-Processing Techniques.	1	2						
					CO3	Apply mining Algorithms for classifying data into differentclasses using labelled data.	1	2						
					CO4	Applying unsupervised learning algorithm for data categorization.	1	2						
					CO5	Implement mining algorithms using modern tolls andtechniques for data processing.		2			5			
2	24CT6105	Deep Learning Concepts	2-0-2-0	3	CO1	Able to understand Deep learning and remember the concepts ofPerception, Back Propagation,	1	2						
					CO2	Able to understand auto encoders- and apply Regularization, andCNN techniques to generate Deep learning models . Apply Long Short Term Memory (LSTM) Restricted Boltzmnn Machines,		2						
					CO3	Build Markov models, Markov networks, Markov chains,			3					
					CO4	Implement basic Neural Networks, optimization algorithms		2	3					
					CO5	Implement basic Neural Networks, optimization algorithms			3		5			
3	24CT6106	Crypt Analysis & Cyber Defence	2-0-2-0	3	CO1	Understand the principles of cryptography by analyzing various attacks and apply different classic encryption techniques.	1							
					CO2	Understand the principles of block cipher and apply algorithmslike DES, AES.					5			
					CO3	Understand and apply different algorithms of public key crypto system for ensuring secured communication and authentication.					5			

					CO4	Understand the concept of elliptic curve and its applications to cryptography. Apply hash algorithms for security.					5			
					CO5	Implement various cryptographic algorithms so as to analyzethe achievability of security goals like Confidentiality, integrity, authentication and also Justify the possibility of cryptanalysis attack with each algorithm.					5			
1	24CT6107	Introduction to Big Data Analytics	2-0-2-0	3	CO 1	Understand the concepts of big data, Initial exploration of analysis of data and Data visualization	1				5			
					CO 2	Understand Initial exploration of data and advanced data analytics by using R		2	3					
					CO 3	Apply advanced algorithms & Statistical modeling for big data using HDFS, HIVE, and PIG.		2		4				
					CO 4	Apply advanced SQL functions for in-database analytics by MADlib, Greenplum along with common deliverables of analytics life cycle project	1	2						
					CO 5	Build and Evaluate the Big Data Analytical problem using R, Hadoop, HIVE Programming concepts.		2		4				
2	24CT6108	Cognitive Computing	2-0-2-0	3	CO1	Understand cognitive computing is, and how it differs from traditional approaches	1							
					CO2	Applying the primary tools associated with cognitive Computing		2						
					CO3	Develop a project that leverages cognitive computing		2						
					CO4	Analyze and discuss the business implications of cognitive computing		2						

					CO5	able to implement cognitive computing programs using IBM Watson			3						
3	24CT6109	Introduction to Block chain & Crypto currencies	2-0-2-0	3	CO 1	Understand the concepts of big data, Initial exploration of analysis of data and Data visualization	1				5				
					CO 2	Understand Initial exploration of data and advanced data analytics by using R		2	3						
					CO 3	Apply advanced algorithms & Statistical modeling for big data using HDFS, HIVE, and PIG.		2		4					
					CO 4	Apply advanced SQL functions for in-database analytics by MADlib, Greenplum along with common deliverables of analytics life cycle project	1	2							
					CO 5	Build and Evaluate the Big Data Analytical problem using R, Hadoop, HIVE Programming concepts.		2		4					

Program Articulation Matrix (Mapping of Courses with POs/SOs/PSOs)

Sl.	Course Code	Course Name	Category	L	T	P	S	Cr	PO							
									1	2	3	4	5	6	7	8
1	24CT5101	Linear Algebra	Core	2	2	0	0	4		2						
2	24CT5102	Relational Algebra and Database Management System	Core	2	0	2	4	4	1				5			
3	24CT5103	Applied Discrete structures	Core	2	2	0	0	4						6		
4	24CT5104	Mathematical Modeling & Numerical Methods using MATLAB	Core	2	0	2	0	3	1	2	3					
5	24CM5105	Computational Thinking for Structured Design through C++	Core	2	0	2	4	4							7	
6	24CT5201	Data Structures and Design of Algorithms	Core	2	0	2	4	4							7	

7	24CT5202	Probability and Statistics	Core	2	0	2	4	4	1	2	3					
8	24CT5203	Matrix Computation	Core	2	0	2	4	4	1	2	3	4	5	6		
9	24CT6102	Mathematical Programming	Core	2	2	0	0	4			3					
10	24CT6103	Transform Techniques for Engineering	Core	2	2	0	0	4	1		3	4		6		
11	24IE5201	Essentials of Research Design	Core	2	0	2	0	3								
12	24CT5110	Stochastic Processes & Optimization	Core	2	2	0	0	4	1					6		
13	24CT5111	Quantum Computing	Core	2	2	0	0	4		2	3	4				
14	24CT5112	Applied Geometry & Computer Graphics	Core	3	0	2	0	4	1				5			
15	24CT6101	Minor Project	Core	0	0	4	4	3								
16	24CT6201	Major Project	Core	0	0	24	16	16								

Elective-I

Sl.	Course Code	Course Name	Category	L	T	P	S	Cr	PO							
									1	2	3	4	5	6	7	8
1	24CT5204	Data Science & Visualization	Core	2	0	2	0	3		2	3		5			
2	24CT5205	Essentials of Machine Learning	Core	2	0	2	0	3		2	3	4	5			
3	24CT5206	Cryptography & Security	Core	2	0	2	0	3	1	2						

Elective –II

Sl.	Course Code	Course Name	Category	L	T	P	S	Cr	PO							
									1	2	3	4	5	6	7	8
1	24CT6104	Data Warehousing & Data Mining	Core	2	0	2	0	3	1	2	3		5			
2	24CT6105	Deep Learning Concepts	Core	2	0	2	0	3	1	2	3		5			
3	24CT6106	Crypt Analysis & Cyber Defence	Core	2	0	2	0	3	1				5			

Elective –III

Sl.	Course Code	Course Name	Category	L	T	P	S	Cr	PO							
									1	2	3	4	5	6	7	8
1	24CT6107	Introduction to Big Data Analytics	Core	2	0	2	0	3	1	2	3	4				
2	24CT6108	Cognitive Computing	Core	2	0	2	0	3	1	2	3					
3	24CT6109	Introduction to Block chain & Crypto currencies	Core	2	0	2	0	3	1	2	3		5	6		

Syllabus of

Courses under various categories

SYLLABUS OF COURSES UNDER

HUMANITIES AND SOCIAL SCIENCES COURSES

I Year I Semester

24UC5201-Professional Communication Skills

L-T-P-S Structure: **0-0-4-0** Credits**: 2** Pre- requisites**: Nil**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO NO			Blooms Taxonomy
CO1	Understand the concepts of grammar to improve communication, reading, and writing skills	PO5	2
CO2	Demonstrate required knowledge over Dos and Don'ts of speaking in the corporate context. Demonstrate ability to face formal situations / interactions.	PO5	2
CO3	Understand the varieties of reading and comprehend the tone and style of the author. Skim and scan effectively and appreciate rhetorical devices	PO5	2
CO4	Apply the concepts of writing to draft corporate letters, emails, and memos	PO5	3

Syllabus :

COMPETENCY: 1: A) Basic Grammar - Countable and uncountable nouns, present simple and continuous, past simple and continuous – classroom practice – Understand and interpret Texts and work place situations B)Structural Pattern - Present continuous for future arrangements State verbs, Regular and irregular verbs, Voice, Modal verbs – Reporting on going tasks in the corporate world. C)Descriptive and Qualitative Patterns: Adjectives and Adverbs classroom practice) Time Expressions, Comparatives and superlatives, Pronouns, Conditionals, Phrases and clauses (Including Relative). COMPETENCY: 2: a) Formal contexts: Being a PA, describing changes in a company Taking orders over the phone. b) Listening & Speaking: Participate in conversation with proper contextual language markers, turn taking. Classroom practice- Presenting context, reason, problem – Case analysis (short). Body Language: Dos and Don'ts of one to one interaction, Telephone interaction Video/ web conferencing. Culture specific practices. Work Etiquette- situation, ambience, team skills, time management and leadership ability. COMPETENCY: 3: Understand and

assimilate main ideas and specific details. (250-300 words text of moderate difficulty). A) Read for general understanding, interpreting, factual or specific information, for grammatical accuracy and information transfer. B) Understand the general meaning of corporate context and office correspondence. d)Understand short reports of predictable nature. COMPETENCY**:** 4: a) Internal Correspondence. Making notes on routine matters, such as, taking/ placing orders. B) Emails: Types of emails, salutations, vocabulary used in formal and informal (Including beginnings and endings). C)Writing straight-forward, routine letters of factual nature.

REFERENCE BOOKS:

R1**.** Business Benchmark Book- Preliminary- 2nd edition Cambridge Press 2019.

R2. Business Benchmark Book- Pre Intermediate to Intermediate- 2nd edition Cambridge Press 2019.

SYLLABUS OF COURSES UNDER

PROJECT BASED COURSES

24IE5201 - Essentials of Research Design

L-T-P-S: 2-0-2-0 **Credits: 3** **Prerequisite: NIL**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Illustrate research objects, steps involved in research and articulate appropriate research questions	PO1	3
CO2	Perform literature review in a scholarly style and apply appropriate methods for data collection.	PO1,PO2	3
CO3	Represent the data in tabular or graphical form and prepare data for analysis.	PO1	3
CO4	Perform statistical modelling and analysis to optimize the data , prepare the data for publishing.	PO1,PO2	3

Syllabus

Introduction to Methodology: Format of thesis and dissertation, Research article, Reviews, Monographs, Bibliography, Literature search, Significance of research, Research methods versus methodology, Research and Scientific
methods, Defining the research Problem and Research design. **Quantitative Methods for Problem Solving:** Introduction to Statistical Modeling and Analysis, Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Spectral Analysis, Error Analysis, Applications of Spectral Analysis. **Physical Statistical Methods:** Definition and Scope; Types of data; Collection and presentation of Data (Tables, Graphs, Diagrams); Measure of Central Tendency; Dispersion; Goodness of fit (X2 Test). **Sampling Fundamentals:** Census and sample Survey, Steps in sample design, Different types sample design, Selection of a random sample, Estimation, Estimating the population mean and population proportion. **Interpretation and Report Writing:** Meaning of interpretation; Techniques of interpretation; Precautions in Interpretation; Significance of Report writing; Different steps in Report writing; Layout of Research Project; Types of Reports; Patent writing and filing and Oral presentation.

Text Books:

1. Kothari, C.R; II ed. (2006), Research Methodology, Methods and techniques; New Age International (p) Ltd., Publishers, New Delhi. :
2. Kumar K. L.' (1997), Educational Technology, New Age International (P) Ltd., New Delhi.

Reference Books:

1. Donald R. Cooper, Pamela S. etc., Business Research Methods,8th Edition, Tata McGraw Hill Co.Ltd.2006
2. Tony Bates A.W. Technology, (2005), e-Learning and Distance Education, New York

SYLLABUS OF COURSES UNDER

PROFESSIONAL CORE

24CT5101 –Linear Algebra

L-T-P-S: 2-2-0-0 **Credits: 4** **Prerequisite: NIL**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No:	Course outcome	PO	BTL
CO1	Describe group, subgroup and quotient groups and their applications.	**PO2**	**3**
CO2	Demonstrate the concepts of homomorphism and automorphisim of groups.	**PO2**	**3**
CO3	Illustrate the theory of rings and its applications.	**PO2**	**3**
CO4	Illustrate the concept of fields and Polynomial Rings.	**PO2**	**3**

Syllabus :

Group theory: Definition and some examples of groups, some preliminary lemmas, subgroups. Homeomorphisms, auto morphisms, Canley's theorem, permutation groups, Solow's theorems. Ring theory: Definition and examples of Rings, some special classes of Rings, homomorphisms Ideal and Quotient rings. Maximal Ideal, Integral domain, Principal Ideal domain(PID), unique factorization. Vector Spaces, Sub Spaces, Dimension, Basis, Inner Product Space, Schewarz inequality, Grahm–Smith Orthogonalization process, Modules, Modules over PID, Modules with chain conditions. Definition of field and some examples, the field of Quotients of an Integral domain, Euclidean rings, polynomial rings.

Suggested Books:

1. Herstein, I. N., "Topics in Algebra", 2nd Ed., John Wiley & Sons., 2004
2. Fraleigh, J. B., "A First Course in Abstract Algebra", 7th Ed., Pearson Education, 2003
3. Dummit, D. S. and Foote, R. M., "Abstract Algebra", 3rd Ed., John Wiley & Sons., 2004
4. Artin M., "Algebra", 2nd Ed., Prentice Hall India, 2011
5. Gallian J. A., "Contemporary Abstract Algebra", 8th Ed., Cengage Learning, 2013.

24CT5102- Relational Algebra and Database Management System

L-T-P-S : 2-0-2-4 **Credits : 4** **Prerequisite : Nil**

Mapping of Course Outcomes (CO) with Program Outcomes (PO) :

CO#	Course Outcome	PO/PSO	BTL
CO1	Illustrate the functional components of DBMS, importance of data modeling in design of a database.	PO1, PO5,	2
CO2	Build queries using SQL and concepts of PL/SQL	PO1,	3
CO3	Apply normalization techniques and indexing to construct and access decent database.	PO5,	3
CO4	Identify the importance of transaction processing, concurrency control and recovery techniques	PO1,	3
CO5	Develop a good database and define SQL queries for data analysis	PO3,	3

Syllabus : Database Fundamentals: DBMS Characteristics & Advantages, Database Environment, Database Users, Database Architecture, Data Independence, Languages, Tools and Interface in DBMS, DBMS types. Data Modelling: ER Model, Notation used in ER Diagram, Constraint, Types, Relationships in ER Model and other considerations in designing ER diagram. Enhanced ER data Model, EER Diagram, Relational Model: concepts, constraints, schemas, ER to Relational Model. Relational Algebra & SQL: Relational Algebra :Operators in relational algebra, Data Definition and other languages in SQL, Creating tables and Data types, Constraints, DML statements, Functions and writing SQL statements using nested sub queries, complex queries, joining relations, views, compound statements, user defined functions, user defined procedures, cursors, Triggers. Database Design: Guidelines for good database design, Normalization- Normal Forms, First, Second, Third Normal Forms, BCNF, Multi value and join dependencies, 4th and 5th normal forms. File and storage structures: File storage, Indexstructures,Indexing and hashing, query processing and optimization. Transaction Management & Recovery Techniques: Transaction processing issues, Transaction states, problems during multiple transactions processing, ACID properties, system log and concurrency control techniques: Lock based techniques, and Timestamp based techniques, Multiversion based Techniques. Recovery concepts, shadow paging, ARIES.

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
1	Ramez Elmasri and shamkant B Navathe, "Database Systems: Models, Languages, Design and Application Programming", 6th Ed., Pearson Education.	**2013**
2	. CONNOLLY,Database Systems : A Practical Approach to Design, Implementation and Management**,** 6thEd., Pearson Education	2010
3	A.Silberschatz Henry F Korth,S.Sudarsan, " Database System Concepts", 6th Ed., Tata McGrawhHill	**2011**
4	Raghu RamaKrishnan , Johannes Gehrke, "Database Management Systems", 3rd Ed., Tata McGraw Hill.	**2014**
5	Ivan Bayross, "SQL, PL/SQL: The Programming Language of Oracle", 2nd Ed., BPB Publications.	2016
6	C. J. Date, A. Kannan and S. Swamynathan, An Introduction to Database Systems, 8th Ed., Pearson Education.	**2009**

List of Lab Experiments:

Experiment - 1:

Introduction to DBS lab, Tools used in the lab(TerraER2.23for ER diagrams, MYSQL5.7server and client)

Experiment - 2:

Draw an ER diagram that captures this information about university database by considering the following information

- Professors have an SSN, a name, an age, a rank, and a research specialty.
- Projects have a project number, a sponsor name (e.g., NSF), a starting date, an ending date, and a budget.
- Graduate students have an SSN, a name, an age, and a degree program (e.g., M.S. or Ph.D.).
- Each project is managed by one professor (known as the project's principal investigator).
- Each project is worked on by one or more professors (known as the projects co-investigators).
- Professors can manage and/or work on multiple projects.
- Each project is worked on by one or more graduate students (known as the project's research assistants).

- When graduate students work on a project, a professor must supervise their work on the project.
- Graduate students can work on multiple projects, in which case they will have a (potentially different) supervisor for each one.
- Departments have a department number, a department name, and a main office.
- Departments have a professor (known as the chairman) who runs the department.
- Professors work in one or more departments, and for each department that they work in, a time percentage is associated with their job.
- Graduate students have one major department in which they are working on their Degree.
- Each graduate student has another, more senior graduate student (known as a Student advisor) who advises him or her on what courses to take.
- Capture dependent details of the professor to offer medical insurance to their family.
- Capture information regarding the clients who sponsored projects to the professors.

Capture information regarding the expenditure and income and details of the project along with

Pedestals.

24CT5103- Applied Discrete structures

L-T-P-S: 2-2-0-0 **Credits: 4** **Prerequisite: NIL**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No:	Course out come	PO	BTL
CO1	Describe the rules of Propositional logic to the arguments of the statements.	**PO6**	**2**
CO2	Illustrate the concept of discrete structures to represent Boolean functions.	**PO6**	**3**
CO3	Construct recurrence relations and solve them.	**PO6**	**3**
CO4	Apply concepts of graph theory for real life problems.	**PO6**	**3**

Syllabus

Proposition, predicate logic, logic connectives, methods of proofs. Mathematical induction. Relation and Function: Definitions and properties, pigeonhole principle, extended pigeonhole principle, equivalence relations and equivalence classes. representation of relations by binary matrices and digraphs; operations on relations. Closure, Warshall's algorithm, discrete numeric functions, growth of functions, big O, big hash function. Partial Order. Partially ordered sets, lattices, isomorphism of lattices - Boolean algebra and Boolean functions, different representations of Boolean functions, application of Boolean functions to synthesis of circuits, circuit minimization and simplification, Karnaugh map. Recurrence Relation: Linear recurrence relations with constant coefficients, homogeneous and non-homogeneous relations, discussion of several special cases to obtain particular solutions. Generating functions, solution of linear recurrence relations using generating functions. Some recursive algorithms. Definition of Graphs, Finite & infinite graphs, Incidence & degree, Walks, paths and circuits, trees, their properties and fundamental circuits, cut-sets and cut-vertices, Euler, Hamiltonian path & circuit, planar graphs, colouring theorems, isomorphism of graphs.

Suggested Books:

1. Kenneth, H. R., Discrete Mathematics and its Applications, 7th Ed., Tata McGraw Hill, 2012
2. Liu, C. L., Elements of Discrete Mathematics, Tata McGraw Hill, 2007
3. Johnsonbaugh, R., Discrete Mathematics, 6thEd., Maxwell Macmillan International, 2006

Reference Books:

1. Mott, J.L., Kandel, A. and Baker, T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall India Pvt Ltd, 2001
2. Kolman, B., Busby, R. and Ross, S.C., Discrete Mathematical Structure, 6th Ed., Pearson, 2008.

24CT5104 - Mathematical Modeling & Numerical Methods using MATLAB

L-T-P-S: 2-0-2-0 **Credits: 3** **Prerequisite: NIL**

CO No:	Course Outcomes	PO's/PSO's	BTL
CO 1	Identify the difference between solutions of system linear and roots of non-linear equations by direct, bisection methods.	PO2, PO3, PS01	3
CO 2	Construct the interpolation forward and backward tables and find the Eigen values and vectors by using mat lab also.	PO1, PO2, PS04	3
CO 3	Apply Numerical differentiation and integration problems for different methods and find the values and compare the values by using mat lab also.	PO2, PS01	3
CO 4	Construct numerical solutions of first and second order ordinary differential equations and compare the numerical values with mat lab also.	PO2, PS04	3
CO 5	Verify the solution of the numerical methods through MATLAB.	PSO3	3

Syllabus

Newton- Raphson method for solution of a pair of non-linear equations. Eigen values and Eigen vectors: Dominant and smallest Eigen values/Eigen vectors by power method. Interpolation: Finite difference operator and their relationships, difference tables, Newton, Bessel and Stirling's interpolation formulae, Divided differences, Lagrange interpolation and Newton's divided difference interpolation. Numerical differentiation: First and second order derivatives by various interpolation formulae. Numerical integration: Trapezoidal, Simpsons $1/3^{rd}$ and $3/8^{th}$ rules with errors and their combinations, Gauss Legendre 2-points and 3-points formulae. Numerical solution of first and second order ordinary differential equations: Picard's method, Taylor's series method, Euler, Modified Euler, Runge-Kutta methods, Predictor-Corrector ,Method's- Milne's method. Modelling with Differential Equation: Population Growth, Graphical Solutions of Autonomous Differential Equations, Drawing a Phase Line and Sketching Solution Curves, Logistic Growth, Numerical Approximation Methods, Using Euler's Method, A Savings Certificate Revisited, Separation of Variables, Newton's Law of Cooling, Population Growth with Limited Resources, Graphical Solutions of Autonomous Systems of First-Order Differential Equations, A Competitive Hunter Model, A Predator--Prey Model.

Suggested Books:

1. Gerald, C. F. and Wheatly, P. O.," Applied Numerical Analysis", 6th Ed., Wesley., 2002
2. Jain, M. K., Iyengar, S. R. K. and Jain, R. K., "Numerical Methods for Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi.l, 2000

Reference Books:

1. Conte, S. D. and DeBoor, C., "Elementary Numerical Analysis", McGraw- Hill Publisher, 1982
2. Krishnamurthy, E. V. & Sen, S. K., "Applied Numerical Analysis", East West Publication. 1998
3. Kapur J. N., “Mathematical Modelling”, New Age International Publishers, 2007.
4. Banerjee Sandip, “Mathematical Modelling Models, Analysis and Applications”, CRC Press, Taylor & Francis Group, 2014.

Textbooks:

1. Giordano, F. R., Fox W. P., and Horton S. B. (2014), A first course in mathematical modeling, Brooks/Cole.
2. Mesterton-Gibbons, M. (1988). A concrete approach to mathematical modeling. Addison-Wesley.

24CT5105- Computational Thinking for Structured Design through C++

L-T-P-S: 2-0-2-4 Credits: 4 Prerequisite: NIL

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No:	Course outcomes	PO/PSO	BTL
CO 1	Describe the basic computer organization and concepts of computer language fundamentals.	**PO7**	**2**
CO 2	Apply the concept of user define functions in C++ for modular programming.	**PO7**	**3**
CO 3	Illustrate user defined C++ functions and different operations on list of data.	**PO7**	**3**
CO 4	Demonstrate the Object Oriented Concepts and implement linear data structures.	**PO7**	**3**
CO 5	Develop the code for the algorithms in C++	**PO7**	**3**

Syllabus

Basic Computer Fundamentals: Introduction to computer systems; number system, integer, signed integer, fixed and floating point representations; IEEE standards, integer and floating point arithmetic; CPU organization, ALU, registers, memory, the idea of program execution at micro level. Basic Programming in C++: Input/output; Constants, variables, expressions and operators; Naming conventions and styles; C; Looping and control structures (while, for, do-while, break and continue); Arrays; File I/O, header files, string processing; Pre-processor directives such as #include, #define, #ifdef, #ifndef; Compiling and linking. Programming through functional decomposition: Design of functions, void and value returning functions, parameters, scope and lifetime of variables, passing by value, passing by reference, passing arguments by constant reference, recursive functions; Function overloading and default arguments; Library functions. Object Oriented Programming Concepts: Data hiding, abstract data types, classes, access control; Class implementation-default constructor, constructors, copy constructor, destructor, operator overloading, friend functions. Introduction to data structures, use of pointers in linked structures. Pointers: Pointers; Dynamic data and pointers, dynamic arrays. Object oriented design (an alternative to functional decomposition) inheritance and composition; Dynamic binding and virtual functions; Polymorphism; Dynamic data in classes.

List of Lab Experiments

Lab session No	List of Experiments	CO-Mapping
1	Write a program that enters a 10- digit telephone number (the first three digits refer to the area code, the next three digits refer to the exchange code, and the remaining four digits refer to number), prints the parts of the number and complete telephone number and addition of area code	CO1

	and exchange code in the following format.	
2	The government of India passed a GO regarding tax payment and you have to develop a C program based on some conditions. If the income is less than 1,50,000 then no tax. If taxable income is in the range 1,50,001-3,00,000 then charge 10% of tax. If taxable income is in the range 3,00,001-5,00,000 then charge 20% of tax. If taxable income is in the range 5,00,001 above then charge 30% of tax. Calculate the amount of tax he/she has to pay.	CO1
3	https://www.hackerrank.com/challenges/staircase Consider value of n = 5: 1 2 3 4 5 2 3 4 5 6 3 4 5 6 7 4 5 6 7 8 5 6 7 8 9 Write a program that prints the above pattern for given n.	CO1
4	a) Write a C++ program to solve the second degree equation $aX^2 + bX + c = 0$ for any real a, b and c. b) Find the greatest and smallest of given 3 numbers	CO2
5	a). A company is having N no of employees. Calculate their net salary the with the following details of HRA,DA and TAX on basic salaryIf basic salary is in between 80000 to 60000 then HRA = 30% DA = 20% Tax= 10% If the basic is in between 59000 to 40000 HRA = 25% (on basic) DA = 12% Tax= 8% If basic is below 39000 DA = 12% Tax= 8% For basic more than 80000 HRA = 30% (on basic) DA = 30% Tax= 20% b) Create a file named "inventory.dat" that stores item name, quantity and price for a single item. Write a program to read the values from the file and calculate bill amount and re write the same into the same file.	CO2
6	a) Write a C++ program to read N values and get their mean and the standard deviation. b) Write a C++ program to perform binary search.	CO2
7	a). Write a C++ program to convert a given decimal number to binary using recursion b) Write an efficient function to return maximum occurring character in the input string e.g., if input string is "test" then function should return 't'.	CO3
8	a) Write a function *reverse (int n)* which reverses the digits of given number and returns the result. For Example, if n is 927 , it would return	CO3

	729 b) Write a C++ program to perform different arithmetic operation such as addition, subtraction, and multiplication using inline function	
9	a) Write a C++ program to swap two number by both call by value and call by reference mechanism, using two functions swap_value() and swap_reference respectively , by getting the choice from the user and executing the user's choice by switch-case. b). Create a class Student which has data members as name, branch, roll no, age ,sex ,marks in five subjects and display them.	CO3
10	a) Write a program to print the names of students by creating a student class. If no name is passed while creating an object of Student class, then the name should be "Unknown", otherwise the name should be equal to the String value passed while creating object of Student class. b) Write a Program to design a class complex to represent complex numbers. The complex class should use an external function (use it as a friend function) to add two complex numbers. The function should return an object of type complex representing the sum of two complex numbers.	CO4
11	Write a program to overload unary operator ++ and – (prefix)	CO4
12	Create a base class basic info with data members name, roll no, sex and two member functions get data and display. Derive a class physical fit from basic info which has data members height and weight and member functions get data and display. Display all the information using object of derived class.	CO4

Suggested Books:

1. H.M. Deitel and P.J. Deitel. C++ How to Program. 8thEd., Prentice Hall.
2. B. Eckel. Thinking in C++ Volume 1 & 2. 2ndEd., Prentice Hall.
3. I. Koren. Computer Arithmetic Algorithms. 2ndEd., A.K. Peters Ltd.
4. S.B. Lippman, J. Lajoie, and B.E. Moo. The C++ Primer. Addison-5thEd., Wesley Professional.
5. S. Oualline. Practical C++ Programming. 2ndEd., O'ReillyMedia.
6. S. Prata. C++ Primer Plus. 5thEd., Sams.
7. W. Stallings. Computer Organisation and Architecture: Designing for Performance. 7thEd., Prentice-Hall.
8. B. Stroustrup. The C++ Programming Language. Addison-3rd Ed., Wesley.
9. R. Lafore. Object-Oriented Programming in C++.4thEd., Sams Publishing.

24CT5201- Data Structures and Design of Algorithms

L-T-P-S: 2-0-2-4 **Credits: 4** **Prerequisite: CTSD**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO#	Course Outcome	PO	BTL
CO1	Analyze and compare stack ADT and queue ADT implementations using linked list and applications.	PO7	4
CO2	Analyze the linked lists and types of Binary trees and their representations.	PO7	4
CO3	Analyze different Sorting Algorithms, linked implementation of Binary, Balanced Trees and different Hashing techniques.	PO7	4
CO4	Analyze different representations, traversals, applications of Graphs and Heap organization.	PO7	4
CO5	Develop and Evaluate common practical applications for linear and non-linear data structures.	PO7	5

Syllabus :

Introduction to data structures. Arrays: One and two dimensional arrays, storage allocations. String representation. Implementation of abstract data types (ADT). Stacks: LIFO structure, push, pop, create, delete and empty stack. Queues: FIFO structure, operations on queues, priority queues, circular queues. Linear lists, list v/s array, internal pointer & external pointer, head, tail of a list, null list, length of a list. Linked Lists: nodes, linked list data structure, algorithms: insert, delete and retrieve node, create, search, print, append linked list, array of linked lists, header nodes, circularly-linked list, doubly linked list: insertion, deletion. Binary trees: definition, array, linked and threaded representations, traversal, (Pre, Post and Symmetric order), expression trees (Infix, Prefix and Postfix). Sorting: Selection sort, bubble sort, exchange sort, quick sort, heap sort and merge sort. Analysis of sorting techniques. Searching: sequential search, binary search, search trees AVL trees, M-way search trees, B trees, hash tables, hashing functions, collision resolution techniques. General lists: Representations, operations, dynamic storage management, garbage collection, compaction. Graphs: array and linked representation, operations: add, delete and find vertex, add, delete edge, traverse graph (depth-first, breadth-first).Networks: minimum spanning tree, shortest path algorithm (Dijkstra's algorithm and Kruskal's algorithm).

List of Lab Experiments :

Lab session No	Experiment	CO-Mapping
1	Traversal, insertion, deletion in a linear array.	CO1
2	Stacks using arrays.	CO1
3	Linear Queue using arrays.	CO1
4	Circular Queue using arrays	CO1
5	Stacks and Queues using linked list.	CO1
6	Singly Linked circular List.	CO1
7	Doubly Linked List.	CO1
8	Polynomial Arithmetic using linked list.	CO1
9	Insertion sort, Exchange sort, Selection sort	CO2
10	Quick sort	CO2
11	Heap Sort.	CO2
12	Binary Tree Traversal (pre, post and symmetric order)	CO4
13	Sequential Search and Binary Search.	CO4
14	Binary Search Tree	CO4

Text Books:

1. Langman, Y., Augenstein, M.; Tennenbaum A.M. Data Structure Using C and C++. Prentice Hall of India.1985
2. Sahni S., Data Structures Algorithms and Applications in C++, McGraw Hill.1999
3. Dale N., C++ Plus Data Structures. Narosa Publications.2012

Reference Books:

1.Tenenbaum A. M., Data Structures Using C, Pearson Edn, India.2011

2.Kruse Robert L., Ryba Alexander J., Data Structures and Program Design in C++. Pearson Edn, India.2009

24CT5202- Probability and Statistics

L-T-P-S: 2-0-2-4 **Credits: 4** **Prerequisite: NIL**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcome (CO)	POS/PSOs	Blooms Taxonomy Level (BTL)
CO1	Understand the basic functions in R programming and identify the operators using in it.	PO1	2
CO2	Simulating data using R	PO2	2
CO3	Apply various probability distributions to the real world problems using R	PO1	2
CO4	Analyze the data using various linear and nonlinear lines using R	PO2	2
CO5	Apply R-Programming to various data sets	PO3	3

Syllabus

Introduction, How to run R, R Sessions and Functions, Basic Math, Variables, Data Types, Vectors, Conclusion, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes. R Programming Structures, Control Statements, Loops, - Looping Over Non vector Sets,- If-Else, Arithmetic and Boolean Operators and values, Default Values for Argument, Return Values, Deciding Whether to explicitly call return- Returning Complex Objects, Functions are Objective, No Pointers in R, Recursion, A Quick sort Implementation- Extended Example: A Binary Search Tree. Doing Math and Simulation in R, Math Function, Extended Example Calculating Probability- Cumulative Sums and Products-Minima and Maxima- Calculus, Functions Fir Statistical Distribution, Sorting, Linear Algebra Operation on Vectors and Matrices, Extended Example: Vector cross Product- Extended Example: Finding Stationary Distribution of Markov Chains, Set Operation, Input /output, Accessing the Keyboard and Monitor, Reading and writer Files, Graphics, Creating Graphs, The Workhorse of R Base Graphics, the plot () Function Customizing Graphs, Saving Graphs to Files. Probability Distributions, Normal Distribution- Binomial Distribution- Poisson Distributions Other Distribution, Basic Statistics, Correlation and Covariance, T-Tests,-ANOVA. Linear Models, Simple Linear Regression, -Multiple Regression Generalized Linear Models, Logistic Regression, - Poisson Regression- other Generalized Linear Models- Survival Analysis, Nonlinear Models, Splines- Decision- Random Forests,

Text Books:

1. The Art of R Programming, Norman Matloff, Cengage Learning
2. R for Everyone, Lander, Pearson

Reference Books:

1. R Cook book, Paul Teetor, Oreilly

2. R in Action, Rob Kabacoff, Manning.

24CT5203 - Matrix Computation

L-T-P-S: 2-0-2-4 **Credits: 4** **Prerequisite: LA**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No:	CO	PO/PSO	BTL
CO 1	Use sophisticated scientific computing and visualization environments to solve application problems involving matrix computation algorithms and Explain the effects of errors in computation and how such errors affect solutions.	PO1 ,PO 2	3
CO 2	Analyze numerical algorithms, and understand the relationships between the computational effort and the accuracy of these algorithms.	PO1 PO2	3
CO 3	CO3 Interpret the results produced by computer implementations of numerical algorithms.	PO3 PO4	3
CO 4	Apply Rayleigh quotient iterations and Explicit and implicit QR algorithms..	PO5 PO6	3
CO5	Demonstrate the necessary analytical background for further studies leading to research in Machine Learning	PO5 PO6	3

Syllabus

Floating point computations, IEEE floating point arithmetic, analysis of roundoff errors; Sensitivity analysis and condition numbers; Linear systems, LU decompositions, Gaussian elimination with partial pivoting; Banded systems, positive definite systems, Cholesky decomposition - sensitivity analysis; Gram-Schmidt orthonormal process, Householder transformation, Givens rotations; QR factorization, stability of QR factorization. Solution of linear least squares problems, normal equations, singular value decomposition(SVD), polar decomposition, Moore-Penrose inverse; Rank deficient least-squares problems; Sensitivity analysis of least-squares problems; Review of canonical forms of matrices; Sensitivity of eigenvalues and eigenvectors. Reduction to Hessenberg and tridiagonal forms; Power, inverse power and Rayleigh quotient iterations; Explicit and implicit QR algorithms for symmetric and nonsymmetric matrices; Reduction to bidiagonal form; Golub- Kahan algorithm for computing SVD.

Text Books:

1. D. S. Watkins, Fundamentals of Matrix Computations, 2nd Ed., John Wiley, 2002.

2. L. N. Trefethen and D. Bau, Numerical Linear Algebra, SIAM, 1997.

Reference Books:

1. G. H. Golub and C. F. Van Loan, Matrix Computations, 3rd Ed., John Hopkins University Press, 1996.

2. J. W. Demmel, Applied Numerical Linear Algebra, SIAM, 1997.

24CT6102 – Mathematical Programming

L-T-P-S: 2-2-0-0 **Credits: 4** **Prerequisite: DS**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No:	CO	PO/PSO	BTL
CO 1	Apply different methods to find the optimal solution of linear programming problems and analyze the sensitivity of the solution.	PO3, PSO1	3
CO 2	Different methods to find the optimal solution of Transportation and Assignment problems.	PO3, PSO1	3
CO 3	Apply non-linear optimization methods to solve non- linear programming problems	PO3, PSO1,	3
CO 4	Apply Search methods to solve non-linear programming problems	PO3, PSO1,	3

Syllabus

Introduction to linear programming: Convex Sets, Graphical Method, Simplex Method, Big – M Method. Two Phase Method, Revised Simplex Method -Duality Theory, Dual Simplex Method, Sensitivity Analysis, Parametric Linear Programming -Transportation Problems and Assignment Problems, Non-linear optimization: Unconstrained and constrained optimization of several variables, Lagrange's multipliers, Khun-Tucker theory, Quadratic Programming –Wolfe's Method. Search Methods- Unconstrained search: Fibonacci Search Method, Constrained search: Penalty function method (Interior and exterior search)

Text Books:

1. Taha, H.A., "Operations Research: An Introduction", MacMillan Pub Co., NY, 9th Ed. (Reprint).2013
2. Mohan, C. and Deep, K., "Optimization Techniques", New Age India Pvt. Ltd, New Delhi. 2009

Reference Books:

1. Mittal, K.V. and Mohan, C., "Optimization Methods in System Analysis and Operations Research", New Age India Pvt. Ltd, New Delhi.1996.
2. Ravindran, A., Phillips, D.T. and Solberg, J.J., "Operations Research: Principles and Practice", John Wiley and Sons, NY, 2nd Ed. (Reprint).20.12.
3. Pant, J.C., "Introduction to Optimization/Operations Research", Jain Brothers, New Delhi, 2nd Ed, 2012.

24CT6103 – Transform Techniques for Engineering

L-T-P-S: 2-2-0-0 **Credits:4** **Prerequisite: LA**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No:	CO	PO/PSO	BTL
CO 1	Apply Laplace transform techniques to solve linear differential equations in system analysis where initial conditions can be easily included to give system response.	PO1, PO3, PO4, PS03	3
CO 2	Applying z- transform and Mellin transform to the analysis and characterization of Discrete Time systems.	PO1, PO3, PS03	3
CO 3	Apply Fourier series to analyze various signals.	PO4, PS03	3
CO 4	Apply Fourier transforms to analyze various signals.	PO6, PS03	3
CO 5	Verify the solution of the Transform techniques through MATLAB.	PSO3	3

Syllabus

Laplace Transform: Laplace of some standard functions, Existence conditions for the Laplace Transform, Shifting theorems, Laplace transform of derivatives and integrals, Inverse Laplace transform and their properties, Convolution theorem, Initial and final value theorem, Laplace transform of periodic functions, Heaviside unit step function and Dirac delta function, Applications of Laplace transform to solve ODEs. **Finite Laplace Transform:** Definition and properties, Shifting and scaling theorem. **Z-Transform:** Z–transform and inverse Z-transform of elementary functions, Shifting theorems, Convolution theorem, Initial and final value theorem, Application of Z-transforms to solve difference equations. **Mellin Transform:** Definition and properties of Mellin transform, Shifting and scaling properties, Mellin transforms of derivatives and integrals, Applications of Mellin transform. **Fourier series:** Trigonometric Fourier series and its convergence. Fourier series of even and odd functions, Gibbs phenomenon, Fourier half-range series, Parseval`s identity, Complex form of Fourier series. Solving ODE using Fourier series. **Fourier Transforms:** Fourier integrals, Fourier sine and cosine integrals, Complex form of Fourier integral representation, Fourier transform, Fourier transform of derivatives and integrals, Fourier sine and cosine transforms and their properties, Convolution theorem, Application of Fourier transforms to Boundary Value Problems.

Text Books:

1. Kreyszig, E., "Advanced Engineering Mathematics", John Wiley & Sons, 2012.
2. Jain, R. K. and Iyenger, S. R. K., "Advanced Engineering Mathematics", Narosa Publishing House. 2009

Reference Books:

1.Hildebrand F. B., "Methods of Applied Mathematics", Courier Dover Publications, 1992.

2.Debanth L. and Bhatta D., Integal Transforms and Their Applications, 2nd Ed., Taylor and Francis Group,2007.

List of Lab Experiments:

Lab session No	List of Experiments	CO-Mapping
1	Introduction and Review of MATLAB.	CO1
2	Determine the Laplace transforms of the function using derivatives and integrals property.	CO1
3	Calculate the Inverse Laplace transforms of the given function.	CO1
4	Solving ODE by Laplace transforms.	CO2
5	Using the Shifting, Convolution, Initial and finalvalue theorems of Z-transforms to the function .	CO2
6	Using Z-transforms to solve the difference equations.	CO2
7	Determine the Mellin transforms of derivatives and integrals.	CO3
8	Obtain the Complex form of Fourier series of the function.	CO3
9	Determine the Fourier series of even and odd functions.	CO3
10	Solving ODE using Fourier series.	CO4
11	Expressing the Fourier sine and cosine integrals and Complex form of Fourier integral representation of the function.	CO4
12	Application of Fourier transforms to Boundary Value Problems (BVP).	CO4

SYLLABUS OF COURSES UNDER

PROFESSIONAL ELECTIVES

24CT5204 - Data Science & Visualization

L-T-P-S: 2-0-2-0 **Credits: 3** **Prerequisite: RADMS**

Course Outcomes:

Mapping of Course outcomes (CO) with program outcomes (PO):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO 1	Understand the modelling of various types of data	PO-3, PSO-2	2
CO 2	Understand the Visualization fundamentals	PO-2, PSO-2	2
CO 3	Apply methods and tools for Non-Spatial DataVisualization	PO-5, PSO-2	3
CO 4	Apply methods for Scientific / Spatial DataVisualization and Web data visualization	PO-5, PSO-2	3
CO 5	Evaluate data visualization through Python &Tableau.	PO-5, PSO-2	5

Syllabus:

Data Modeling: Conceptual models, Spread sheet models, Relational Data Models, object oriented models, semi structured data models, unstructured data models. Visualization Fundamentals, Design principles, The Process of Visualization, Data Abstraction. Visual Encodings, Use of Color, Perceptual Issues, Designing Views, Interacting with Visualizations, Filtering and Aggregation Design Studies Information / Non-Spatial DataVisualization, Tabular Data, Tree Data, Graph Data, Text Data, Flow Data, Time-Series Data, Topological Visualization, Uncertainty, Visual Analytics. Scientific / Spatial Data Visualization, Scalar Volumes, Iso-surfacing, Volume Rendering, Transfer Function Design, Vector Fields, Maps, Spatial Uncertainty Web data visualization: web structure data, web usage data ,web content data multimedia data visualization Information dashboard – categorizing dashboards – typical dashboard data – dashboard design issues and best practices. Visual perception – limits of short-term memory – visually encoding data – Gestalt principles – principles of visual perception for dashboard design Characteristics of dashboards – key goals in visual design process – dashboard display media – designing dashboards for usability – meaningful organization – maintaining consistency – aesthetics of dashboards – testing for usability – case studies: sales dashboard, CIO dashboard, Telesales dashboard, marketing analysis dashboard.

Textbooks:

1. Fry, Visualizing Data. O'Reilly Media, 2008, ISBN 0596514557.
2. Munzner, Visualization Analysis and Design, 2014, ISBN 1466508914
3. Ware, Information Visualization: Perception for Design, 3rd ed. Morgan Kaufmann,2012, ISBN 0123814642.

Reference books:

1. Paulraj Ponniah, "DATA MODELING FUNDAMENTALS", A Practical Guide for IT Professionals.
2. Stephen Few, "Information dashboard design: The effective visual communication ofdata",O'Reilly, 2006.

24CT5205 – Essentials of Machine Learning

L-T-P-S: 2-0-2-0 **Credits: 3** **Prerequisite: LA & DS**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO 1	Understand the basic terminology and measurementsof Machine Learning and Apply Machine Learning techniques using Tree and Bayesian models.	PO-3, PSO-2	3
CO 2	Apply and analyze Neural Network and SVM Modelsfor solving Classification and Prediction problems	PO-4, PSO-2	4
CO 3	Apply Dimensionality reduction methods, Evolutionary learning and Ensembles methods to solve classification problems	PO-3, PSO-2	3
CO 4	Illustrate different unsupervised models, Analytical, Explanation-Based and reinforcement learning methods	PO-2	2
CO 5	Implement Machine Learning Techniques using Python Language	PO-2, PO-5, PSO-2	5

Syllabus:

Introduction: Learning, Types of Machine Learning, Supervised Learning: The Machine Learning Process, Performance Measures, The Bias-Variance Tradeoff, Learning with Trees: Using Decision Trees, Constructing Decision Trees, Classification and Regression Trees (CART), Turning Data into Probabilities: The Naïve Bayes' Classifier, Bayesian Networks. The EM Algorithm: Estimate Means of KGaussians, General Statement of EM Algorithm Neural Networks: The Brain and The Neuron, Neural Networks, The Perception, Linear Separability, The Multi-Layer Perceptron: Going Forwards, Going Backwards Back-Propagation of Error, The Multi-Layer Perception in Practice, Deriving Back- Propagation. Support Vector Machines: Optimal Separation, Kernels, The Support Vector Machine Algorithm, Extensions to the SVM. Dimensionality Reduction: The Curse of Dimensionality, Linear Discriminate Analysis, (LDA), Principal Components Analysis (PCA), Evolutionary Learning: The GeneticAlgorithm (GA), Generating Offspring: Genetic Operators, Using Genetic Algorithms. Ensemble Learning: Boosting, Bagging and Random Forests. Unsupervised Learning: The k-means algorithm, Hierarchical Clustering, The Self-Organizing Feature Map. Explanation based Learning, ReinforcementLearning and Evaluating Hypotheses: Introduction, Learning Task, Q Learning, Non-Deterministic Rewards and Actions. Active Reinforcement Learning, Generalization in Reinforcement Learning.

Textbooks:

1. Stephen Marsland, "Machine Learning an Algorithmic Perspective", CRC Press,(2009).
2. Tom M. Mitchell, "MachineLearning", McGrawHill, 1997.

Reference books:

1. Peter Harrington, “Machine Learning in Action”, Manning Publications
2. Ethem lpaydin, “Introduction to Machine Learning”, The MIT Press, (2010).
3. Programming Python by Mark Lutz, O'Reilly
   Chun, J Wesley, Core Python Programming, 2 nd Edition Pearson 2007 Reprint

24CT5206 –Cryptography and Security

L-T-P-S: 2-0-2-0 **Credits: 3** **Prerequisite: LA**

Mapping of Course outcomes (CO) with program outcomes (PO):

Course Outcomes:

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO 1	Apply error detection and correction mechanisms to compute codewordsfor the source code and outline the working of OSI & TCP/IP reference models.	PO-1, PO-2	3
CO 2	Infer Channel allocation problem and algorithms to avoid it and computethe optimal path in a network using various static and dynamic routing algorithms.	PO-1, PSO-1	2
CO 3	Identify the IP addresses of a network using IPV4 classful & classless addressing schemes and outline the functionalities of the transport layerlike TCP Connection management and congestion control.	PO-1, PO-2	3
CO 4	Apply different symmetric and asymmetric encryption algorithms to compute ciphertext and identify the functionality of application layerprotocols.	PO-1, PO-2	3

Syllabus:

Overview of networking using the Internet as an example, networks topologies, LANs and WANs, OSI reference model, Internet TCP/IP Protocol Stack. Link layer: Link layer services, error detection and correction. Sliding Window, Stop and Wait protocols. MAC Layer: Aloha, CSMA, CSMA/CD, CSMA/CA protocols. Network layer: Network layer design issues, Routing algorithms: Shortest path, Flooding, Distance vector, Link state, Hierarchical, broadcast and multicast routing. Congestion control algorithms, QoS. Internetworking, IPv4, Network Address Translation, ARP, OSPF, BGP Transport layer: Elements of Transmission protocols, UDP, TCP. Application layer: WWW, HTTP, electronic mail, Domain Name System Network Security: Introduction to Security: Security Concepts, Security Attacks, Security Services and Mechanisms, A Security Model, Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Overview on DES, Asymmetric Encryption Algorithm- RSA.

Textbooks:

1. Kurose, J and Ross, K Computer Networking: A Top-Down Approach Addison-Wesley- 6thedition-(2012).
2. A.S. Tanenbaum, David J. Wetheral “Computer Networks” Pearson, 5th –Edition-(2011).

Reference books:

1. Behrouz A. Forouzan , “Data Communication and Networking”, TMH, 5th Edition ,(2012).

2. William Stallings, “Cryptography and Network Security”, Pearson Education, 6th Edition, 2015.
3. Peterson, LL and Davie BS “Computer Networks -- A Systems Approach”, Morgan Kaufmann,Elsevier,-5th edition-(2012).

24CT6104 - Data Warehousing & Data Mining

L-T-P-S: 2-0-2-0 **Credits: 3** **Prerequisite: DSV**

Mapping of Course outcomes (CO) with program outcomes (PO):

Course Outcomes:

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO 1	Understand Data Warehousing Techniques and apply different data processing techniques.	PO-2, PO-1, PSO-1	2
CO 2	Implementation of Data Pre-Processing Techniques.	PO-1, PO-2, PSO-1	2
CO 3	Apply mining Algorithms for classifying data into different classes using labeled data.	PO-1, PO-2, PO-3, PSO-1	3
CO 4	Applying unsupervised learning algorithm for data categorization.	PO-1, PO-2, PO-3, PSO-1	3
CO 5	Implement mining algorithms using modern tolls and techniques for data processing.	PO-5, PO-2, PO-3, PSO-2	5

Syllabus:

Introduction to Data Warehouse and mining, Data Discretization and Concept hierarchy generation, Overview of ETL and OLAP OLTP integration – comparison of OLAP with OLTP systems, ROLAP, MOLAP and DOLAP, Data Cuboids Computation method, multi- dimensional modelling, Attribute-oriented Induction, Data Warehouse architecture and implementation. KDD, Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Data Preprocessing- Data Cleaning methods, Descriptive Data Summarization, Data Reduction, Correlation, Regression Analysis. Data Mining Techniques: Classification by decision tree induction, Bayesian Classification, Classification Back-propagation, Basic concepts of Association Rule Mining, Frequent Item set mining, Apriori Algorithm, Mining various kinds of association rules, Rule- based Classification, Associative Classification, SVM, Performance Analysis. Supervised and Unsupervised learning, Clustering methods, Partitioning-Based Clustering Methods, Hierarchical Clustering Methods; Density Based and Grid-Based Clustering Methods, Algorithms for mining of spatial data, multimedia data, text data.

Textbooks:

1. Han J &Kamber M, “Data Mining: Concepts and Techniques”, Third Edition, Elsevier,2011.
2. Pang-Ning Tan, Michael Steinback, Vipin Kumar, “Introduction to Data Mining”,Pearson Education, 2008

Reference books:

1. M.Humphires,M.Hawkins, M.Dy,“Data Warehousing: Architecture and Implementation”, Pearson Education, 2009.

2. Anahory, Murray, “Data Warehousing in the Real World”, Pearson Education, 2008.
3. Kargupta, Joshi,etc., “Data Mining: Next Generation Challenges and Future Directions”,Prentice Hall of India Pvt Ltd, 2007.

24CT26105 – Deep Learning Concepts

L-T-P-S: 2-0-2-0 **Credits: 3** **Prerequisite: ML**

Mapping of Course outcomes (CO) with program outcomes (PO):

Course Outcomes:

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO 1	Able to understand Deep learning and remember the concepts of Perception, Back Propagation,	PO-1, PO-2, PSO-1	2
CO 2	Able to understand auto encoders- and apply Regularization, and CNN techniques to generate Deep learning models	PO-2, PSO-1	3
CO 3	Apply Long Short Term Memory (LSTM) RestrictedBoltzmannMachines,	PO-3, PSO-1	3
CO 4	Build Markov models, Markov networks, Markov chains,	PO-3, PO-2, PSO-2	3
CO 5	Implement basic Neural Networks, optimization algorithms	PO-3, PO-5, PSO-2	5

Syllabus:

History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptron's, Perceptron Learning Algorithm and Convergence, Multilayer Perceptron's (MLPs), Representation Power of MLPs, Sigmoid Neurons, Feedforward Neural Networks, Backpropagation, Gradient Descent (GD), Momentum Based GD, Auto encoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders, Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing andtying, Injecting noise at input, Ensemble methods, Dropout, Greedy Layer wise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization, Learning Vectorial Representations Of Words Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet Object Detection, RCNN, Fast RCNN, Faster RCNN, YOLO. Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks , Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, Gated Recurrent Units (GRUs), Long Short Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs Encoder Decoder Models, Attention Mechanism, Attention over images, Hierarchical Attention Directed Graphical Models, Markov Networks. Using joint distributions for classification and sampling, Latent Variables, Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs, Variational autoencoders, Autoregressive Models:NADE, MADE, PixelRNN , Generative Adversarial Networks (GANs)

Textbooks:

1. 1.Deep learning with python – Francois Chollet, Manning publishers, 2018, ISBN-9781617294433
2. Grokking deep learning, Andrew w Trask, 2019, Manning publishers, ISBN-9781617293702
3. Ian Goodfellow and Yoshua Bengio and Aaron Courville (2016) Deep Learning Book.

Reference books:

1. Deep Learning with PyTorch: A practical approach to building neural network modelsusing PyTorch by Vishnu bramanianNeural Networks: A Systematic Introduction,Raúl Rojas, 1996
2. PatternRecognition and Machine Learning, Christopher Bishop, 2007

24CT6106 – Cryptanalysis & Cyber Defense

L-T-P-S: 2-0-2-0 **Credits: 3** **Prerequisite: ISC**

Mapping of Course outcomes (CO) with program outcomes (PO):

Course Outcomes:

CO #	Course Outcome	PO/PSO	BTL
CO1	Understand the principles of cryptography by analyzing various attacks and apply different classic encryption techniques.	PO1,PSO2	3
CO2	Understand the principles of block cipher and apply algorithms like DES, AES.	PO5,PSO2	3
CO3	Understand and apply different algorithms of public key crypto system for ensuring secured communication and authentication.	PO5,PSO2	3
CO4	Understand the concept of elliptic curve and its applications to cryptography. Apply hash algorithms for security.	PO5,PSO2	3
CO5	Implement various cryptographic algorithms so as to analyze the achievability of security goals like Confidentiality, integrity, authentication and also Justify the possibility of cryptanalysis attack with each algorithm.	PO5,PSO2	4

Syllabus:

Introduction to Security: Security Concepts, Security Attacks, Antivirus bypassing, Pasword Attacks and Web browser exploitation, Security Services and Mechanisms, A Security Model, Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques. Block Ciphers and DES: Traditional Block Cipher Structure, DES, DES Example, Strength of DES, Basic concepts in Number Theory and Finite Fields, Division Algorithms, Euclidean Algorithm, Modular Algorithm, Groups, Rings and Fields, Polynomial Arithmetic, Finite Fields of the form GF(2n), Differential and Linear Cryptanalysis, Block Cipher Design Principles. AES: Finite Field Arithmetic, AES Structure, AES Transformation Functions, AES Example, AES implementation. Block Cipher Operation: Multiple Encryption and Triple DES, Modes of Operation,XTS mode for Block Oriented Storage Device, Pseudorandom Number Generation and Stream Ciphers: Principles and Pseudorandom Number Generation, Pseudorandom Number, Generators, Pseudorandom Number Generation using a Block Cipher, Stream, Ciphers, RC4, Fermats and Euler's Theorem, Testing for Primality, Chinese Remainder Theorem, Discrete Logarithm, Public-key Cryptography and RSA: Principles of Public-Key cryptosystems, the RSA algorithm. Other Public-key Cryptosystems: Diffie- Hellman Key Exchange, ElGamal Cryptosystem, Elliptic Curve Arithmetic Elliptic Curve Cryptography, Pseudorandom Number Generation based on an Asymmetric Cipher. Cryptographic Hash Functions: Applications of Cryptographic Hash functions, Two Simple Hash Functions, Requirements and Security, Hash Functions based on Cipher Block Chaining, SHA.

Text Books:

1. Cryptography and Network Security Principles and Practice, by William stallings, Pearson,5th edition.
2. Applied Cryptography: Protocols, Algorthms, and Source Code in C, by Bruce Schneier,Second Edition, John Wiley & Sons, Inc., 2015.

Reference Books:

1. Applied Cryptography for Cyber Security and Defense: Information Encryption and Cyphering, by Hamid R. Nemati and Li Yang, IGI Global, 2011
2. Forouzon B, “Cryptography and Network Security,” Indian Edition, TMH (2010).

24CT6107 – Introduction to Big Data Analytics

L-T-P-S: 2-0-2-0 **Credits: 3** **Prerequisite: DSV**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO 1	Understand the concepts of big data, Initial exploration of analysis of data and Data visualization	PO-1, PO-5, PSO-2	2
CO 2	Understand Initial exploration of data and advanced data analytics by using R	PO-2, PO-3, PSO-2;	2
CO 3	Apply advanced algorithms & Statistical modeling for big data using HDFS, HIVE, and PIG.	PO-2, PO-4, PSO-1	3
CO 4	Apply advanced SQL functions for in-database analytics by MADlib, Greenplum along with common deliverables of analytics life cycle project	PO-1, PO-2, PSO-1	3
CO 5	Build and Evaluate the Big Data Analytical problem using R, Hadoop, HIVE Programming concepts.	PO-2, PO-4, PSO-2	5

Syllabus:

Introduction to Big Data Analytics: Big Data Overview, State of the Practice of Analytics, Big Data Analytics in Industry Verticals. It also covers Overview of Data Analytics Lifecycle, Discovery, Data Preparation, Model Planning, Model Building, Communicating Results and Findings, and Operationalizing. Initial Analysis of the Data: Initial Exploration and Analysis of the Data, Basic Data Visualization. Basic data analytics, reporting, and applying basic data visualization techniques to your data. Apply basic analytics methods such as distributions, statistical tests, and summary operations, and differentiate between results that are statistically sound vs. statistically significant. Identify a model for your data and define the null and alternative hypotheses. Experimentation and demonstration of the initial analysis of data using R. Advanced Analytics and Statistical Modeling for Big Data — Theory and Methods: Need to analyze and select an appropriate technique based on business objectives; initial hypotheses; and the data's structure and volume. Apply some of the more methods in Analytics solutions, algorithms, and the technical foundations for the methods. The environment (use case) in which each technique can provide the most value. Use appropriate diagnostic methods to validate the models created Use R and in-database analytical functions to fit, score, and evaluate models. Advanced Analytics and Statistical Modeling for Big Data — Technology & Tools: Tool to Perform Analytics on Unstructured data using MapReduce Programming paradigm. Use Hadoop, HDFS, HIVE, PIG and other products in the Hadoop ecosystem for unstructured data analytics. Effectively use advanced SQL functions and Greenplum extensions for in-database analytics. Use MADlib to solve analytics problems in a database. Endgame - Operationalizing an Analytics Project: Tasks needed to operationalize an analytics project. Four common deliverables of an analytics lifecycle project meet

the needs of key stakeholders. Use a framework for creating final presentations for sponsors and analysts. Evaluate data visualization and identify ways to improve it.

Textbooks:

1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services 2014
2. MapReduce Design Patterns, Author: Donald Miner, Publisher: O'Reilly(2012), ISBN-13:-9789350239810
3. Practical Data Science with R Manning, 1st Edition, 2014, Nina Zumel, John Mount
4. Big Data Analytics with R and Hadoop, Packt Publishing, 2013 by Vignesh Prajapathi.

Reference books:

1. Practical Data Science with R Manning, 1st Edition, 2014, Nina Zumel, John Mount
2. Big Data Analytics with R and Hadoop, Packt Publishing, 2013 by Vignesh Prajapathi.
3. Hadoop TheDefenitive Guide, O'REILLY, Second Edition, Yahoo Press.

24CT6108 – Cognitive Computing

L-T-P-S: 2-0-2-0 **Credits: 3** **Prerequisite: ML**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand cognitive computing is, and how it differs from traditional approaches	PSO1,PO1	2
CO2	Applying the primary tools associated with cognitive Computing	PO1,PSO2	3
CO3	Develop a project that leverages cognitive computing	PSO2,PO2	4
CO4	Analyse and discuss the business implications of cognitive computing	PSO2,PO2	4
CO5	able to implement cognitive computing programs using IBM Watson	PSO2,PO3	5

Syllabus:

Introduction to Cognitive Systems and computation, Knowledge based AI: Cognitive systems. Artificial Intelligence as the Foundation of Cognitive Computing, Understanding Cognition, The Elements of a Cognitive System, Cognitive Applications. Design Principles for Cognitive Systems: Building the Corpus, Bringing Data into the Cognitive System, Machine Learning, Hypotheses Generation and Scoring, Presentation and Visualization Services. Cognitive Functioning: Learning, Memorising, Adaptation, Self Origination, Control, Thinking, Reasoning, Decision Making & Judgement. Natural Language Processing in Support of a Cognitive System: The Role of NLP in a Cognitive System Understanding Linguistics, Applying Natural Language Technologies to Business Problems. Representing Knowledge in Taxonomies and Ontologies: Developing a Cognitive System, Models for Knowledge Representation, Other Methods of Knowledge Representation. Mental States: Belief Desire Intention (BDI) emotion and feeling. Computation of Cognitive Functioning in machines: Applying Advanced Analytics to Cognitive Computing: Key Capabilities in Advanced Analytics,Using Machine Learning in the Analytics Process, Predictive Analytics Text Analytics, Image Analytics, Speech Analytics Using Advanced Analytics to Create Value. Business Implications: Advantages of New Disruptive Models, The Difference with a Cognitive Systems Approach, IBM's Watson:DeepQA Architecture" Robotics, Human-Robotics Interaction, Hepatic. Perception and sensing: Building Cognitive Applications: Defining the Objective, Defining the Domain, Defining Questions and Exploring Insights, Building a Cognitive Healthcare Application, Smarter Cities: Cognitive Computing in Government.

Text Books:

1. A Brief Introduction to Neural Networks,http://www.dkriesel.com/,2009 by DavidKriesel
2. Reinforcement Learning:An Introduction online: http://webdocs.cs.ualberta.ca/~sutton/book/the-book.html?,Second Edition by Richard S.Sutton and Andrew G. Barto
3. Artificial Intelligence and Soft Computing: Behavioral and Cognitive Modeling of theHuman Brain, CRC Press,2018 by Amit Konar
4. Artificial intelligence and tutoring systems: computational and cognitive approaches tothe communication of knowledge, Morgan Kaufmann, INC,2014 by Etienne Wenger
5. Machine Learning for Decision Makers: Cognitive Computing Fundamentals for BetterDecision Making, APRESS,2018 by Patanjali Kashyap.

24CT6109 – Introduction to Block chain and Crypto currencies

L-T-P-S: 2-0-2-0 **Credits: 3** **Prerequisite: ISC**

Mapping of Course outcomes (CO) with program outcomes (PO):

Course Outcomes:

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO 1	To apply the concepts of number theory and its applications in cryptography	PO-1, PO-2	3
CO 2	To understand the basics of blockchain	PO-2	2
CO 3	To apply different types of blockchain and consensus algorithms for contract transaction	PO-3	3
CO 4	To apply the different types of crypto currencies to crypto applications	PO-5, PO-12	3
CO 5	To analyse basic number theory, cryptography concepts and smart contracts applications using soft walltet.	PO-6	4

Syllabus:

Introduction to Number Theory: Chinese Remainder Theorem, Fermat's Little Theorem, Euler Theorem and Euler Totient function properties. Introduction to Cryptography: Symmetric key cryptography – asymmetric key cryptography – types of attacks – authentication – SHA- 256 Hash algorithm – RSA algorithm – Elliptic Curve cryptography – Digital signature standard **.** Basics of Blockchain concepts: Architecture – Properties of Blockchain – Distributed ledger – Merkle tree – structure of a block – Smartcontract – Crowd funding – Transaction – Double spending – Block propagation – Consensus – Proof of Work, Proof of Stack, Proof of Burn, Proof of Elapsed Time – Mining. Types of Blockchain: Blockchain Compenents – Permissioned Blockchain – Permissionless Blockchain – Consortium Blockchain – Consensus Algorithms: PAXOS consensus Algorithm – RAFT consensus Algorithm – Byzantine general problem – Practical Byzantine fault tolerance Algorithm – Three phase commit Protocol Cryptocurrencies: Cryptocurrencies applications using blockchain – Bitcoin: Bitcoin properties – Transaction life cycle – creation of coin – sending payments – double spending using blockchain – bitcoin anonymity – Ether: Ethercoin properties – smart contract – Hyperledger Fabric: Transaction Flow – Fabric Details: Ordering Services, Channels (Single and Multiple Channels), Peer, Client Applications, Certificate Authority – Membership and Identity Management – Applications: Financial Services: Cross border payments, KYC, international trade – Health Care: Food safety

Textbooks:

1. Behrouz A. Forozan and Debdeep Mukhopadhyay, "Cryptography and Network Security", 3rd Edition, McGraw Hill Education (India) Private Limited, 2015.
2. William Stallings, "Cryptography and Network Security: Principles and Practice",

7thEdition, Pearson Education, 2017.
3. Chandramouli Subramanian, Asha A George, Abhilash K A, Meena Karthikeyan, "Blockchain Technology", University Press (India) Private Limited, 2021

Reference books:

1. Melanie Swan, Blockchain: Blueprint for a New Economy, O'Reilly Media, Inc., 2015.
2. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System.
3. IOTA: a cryptocurrency for Internet-of-Things (2017), URL: https://iota.org
4. IOTA Developer Hub (2017), URL: https://www.iota.org/research/meetthe-tangle
5. Dr. Gavin Wood, "ETHEREUM: A Secure Decentralized Transaction Ledger,"Yellow paper.2014.
6. Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereumsmart contracts.

SYLLABUS OF COURSES UNDER FLEXI CORE COURSES

24CT5110 - Stochastic Processes & Optimization

L-T-P-S: 2-2-0-0 **Credits: 4** **Prerequisite: P & S**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No:	CO	PO/PSO	BTL
CO 1	Describe the concept of Markov process and Poisson Process.	PO1	3
CO 2	Illustrate Queuing models and Demonstrate the concepts of Brownian motions and applications	PO6	3
CO 3	Formulate LPP and solve LPP. Model and solve Transportation and Assignment problems.	PO6	3
CO 4	Apply Geometric programming and Ant-colony Optimization and PSO. Solve decision making techniques to solve real life problems.	PO6	3

Syllabus:

Discrete-Time Markov Models: Discrete-Time Markov Chains, Transient Distributions, Occupancy Times, Limiting Behavior, First-Passage Times. **Poisson Processes:** Poisson Processes, Superposition of Poisson Processes, Thinning of a Poisson Process, Compound Poisson Processes. **Continuous-Time Markov Models:** Continuous-Time Markov Chains, Transient Analysis: Uniformization, Occupancy Times, Limiting Behavior, First-Passage Times. **Generalized Markov Models:** Renewal Processes, Cumulative Processes, Semi-Markov Processes. **Queueing Models:** Queueing Systems, Single-Station Queues, Birth and Death Queues. **Brownian Motion:** Standard Brownian Motion, Brownian Motion, First-Passage Times, Martingales and Semimartingales, Black Scholes Formula. Introduction to LPP: Formulation of LP models, Graphical procedure of solution, Convex functions and their properties, Basic feasible solution, Optimal solution. Simplex method, Transportation Problems: VAM Method, Optimality Test, Degeneracy, Unbalanced Transportation problem, Assignment problems, Travelling salesman problem. Integer LPP - Branch and Bound Algorithm, Cutting Plane Algorithm. Geometric Programming: Problems with one-degree of difficulty with positive coefficients, Geometric programming with constraints, Problems with positive and negative coefficients. Heuristic and Meta heuristics, Single solution vs. population-based, Parallel meta heuristics, Evolutionary algorithms, Nature-inspired meta heuristics, Genetic Algorithm, Ant-colony optimization, Particle swarm optimization, Simulated annealing.

Text Books:

1. Taha, H.A., "Operations Research: An Introduction", MacMillan Pub Co., NY, 9th Ed. (Reprint)., 2013
2. Rao, S. S.," Optimization", Wiley Eastern India, Fourth Edition
3. Hadley G., Linear Programming, Addison-Wesley

Reference Books

1. Ravindran, A., Phillips, D.T. and Solberg, J.J., "Operations Research: Principles and Practice", John Wiley and Sons, NY, 2nd Ed. (Reprint).

2. Hillier F.S. and Lieberman G.J., Introduction to Operation Research, McGraw Hill., 9th Edition.

24CT5111 – Quantum Computing

L-T-P-S: 2-2-0-0 **Credits: 4** **Prerequisite: MM**

Mapping of Course outcomes (CO) with program outcomes (PO):

CO-NO	Course Outcome	PO/PSO	Blooms Taxonomy Level (BTL)
1	To introduce basics of quantum computing	PO2,PSO2	2
2	Implementing Quantum computing algorithms	PO3,PSO2	3
3	Applying concepts of Quantum computing using QISKIT	PO3,PSO2	3
4	Analyze and Discuss Quantum Machine learning and deep learning concepts with applications	PO4,PSO3	4
5	Practicals on all algorithms discussed above	PO3, PSO3	4

Syllabus:

Introduction and Basics of Quantum computing. Overview of classical mechanics, Drawbacks of classical mechanics, Quantum mechanics origin, Building blocks of quantum mechanics, Introduction to quantum computing, Quantum states and qubits, Single qubit gates, Multiple qubits and entanglement, Quantum circuits, Applications. Quantum computing algorithms. Deutsch Jozsa algorithm, Bernstein Vazirani algorithm, Simons algorithm, Quantum fourier transform, Shors algorithm, Grovers algorithm, Superdense coding. IBM QISKIT Implementation Setting up environment, Python and Jupiter notebooks configuring, Quantum circuits implementation, Quantum measurement, Quantum phase estimation, Scalable shor's algorithm, Grover's algorithm. Quantum Machine learning Unsupervised learning, Pattern recognition and neural networks, Supervised learning, Support vector machines, Regression analysis and boosting, Quantum clustering and classification, Adiabatic quantum computing, Quantum teleportation and game theory, Applications, Quantum Deep learning

Textbooks:

1. Quantum Machine learning, Peter Wittek, Elsevier Publisher
2. Quantum computing for everyone, Chris Bernhardt, MIT

24CT5112 - Applied Geometry & Computer Graphics

L-T-P-S: 3-0-2-0 **Credits: 4** **Prerequisite:** DS

Mapping of Course outcomes (CO) with program outcomes (PO):

COURSE OUTCOMES (Cos):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	To understand Basics of Augmented Reality and Interactions.Fundamentals of Augmented , Mixed Reality and its features P	PSO1,PO1	3
CO2	To understand Basics of Virtual Reality and Interactions.Fundamental Concept and Components of Virtual Reality	PO1,PO5,PSO2	3
CO3	To understand Graphics Pipelines, Creating a sampleaugmented reality apps in android	PSO2,PO1, PO5	3
CO4	To apply Unity development Environment, IDE Basics, Sprites,User Interfaces, Simple 3D animation Creation	PSO2,PO5	3
CO5	Develop applications through Lab experiments	PO1,PO5,PSO2	3

Syllabus:

Introduction to Augmented Reality -Augmented Reality Interactions, Monitor Based Displays, Head mounted Displays, Ar Interaction, ArTracking, Augmented and Mixed Reality, Technology and features of augmented reality, Typical AR Experiences, Difference between AR, VR and MR, Challenges with AR, AR systems, Simultaneously Localize and Map Environment, OpticalTracking, AR Tracking and registration, Markers, Holography and Photography, AR System Evaluation. Introduction to Virtual Reality- Historical development of VR Fundamental Concept and Components of Virtual Reality, Architecture of Virtual Reality, Primary Features and Present Development on Virtual Reality, Typical VR System, The three I's of virtual reality, commercial VR technology and the five classic components of a VR system, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement ,VR Content, Factors in Virtual Reality, Benefits of virtual reality, Typical System Delays, VR Graphics Architecture.

The Graphics Pipeline VR– Panorama, Stereo Movie, Stereo Panorama, Mono Panoramas, Comparison: Mono and Stereo Panoramas, Spatial Audio for VR, Ambisonics, Motion Sickness– Spherical Harmonics, Engines& Unity, VR Engines – Audio ,3D Audio, Physics, User Interface (UI), VR Engines – Content Creation, Latency, Post-rendering Warp, Eye Tracking. Introduction to Game

Development – Unity Development Environment, IDE Basics, Sprites, UserInterfaces, Prefabs, Simple 3D animation Creation, Vuforia Engine, Finitudes, ARCore, ARKit, Vumarks Designer, Marker based AR with Vuforia and Unity, User Defined Target, Avengers on table using Umar's, Multiple Image Targets and Umar's with Vuforia and unity, adding shadowto Scene.

Text Books:

1. Alan B. Craig, "Understanding Augmented Reality: Concepts and Applications", Nunes.
2. William R. Sherman and Alan B. Craig, "Understanding Virtua/Reality ", MorganKaufmann Publishers.
3. James C Shensi Android Application development for java programmers, CengageLearning.
4. Mike McCaffery and David Graham, "Game Coding Complete", Fourth Edition, CengageLearning, PTR,2012.

Reference Books:

1. Brett S. Martin, "Virtual Reality", Norwood House Press, 2017
2. John Vince, "Virtual Reality Systems", Pearson Education.
3. Wallace Jackson, Android apps for absolute Beginners Apress.
4. Ernest Adams and Andrew Rolling, "Fundamentals of Game Design", 2nd EditionPrentice Hall / NewRiders,2009.