School of Science and Computer Studies

MASTER OF SCIENCE IT in Data Science
(MSc IT DS)

Scheme of Teaching and Evaluation (STE)
Batch [2024-26]

Vision and Mission – CMRU

Vision

To nurture creative thinkers who will drive positive global change

Mission

- To offer multi, inter and cross-disciplinary modular programmes with technology-enabled teaching-learning processes.
- To focus on research-led teaching and learning in an innovative and interdisciplinary learning environment; to create critical thinkers.
- To create leaders for a knowledge based economy, with ethical demands of a society base.
- To engage talented intellectual capital with strong faculty diversity in knowledge and experience.
- To ensure transformation of learning into positive behavior of students.

Vision and Mission – SSCS

Vision:

To provide high-quality education that cultivates globally recognized technocrats and entrepreneurs in Computer Science and Technology, equipped with ethical principles, cutting-edge knowledge, and innovative ideas, to meet industry demands and societal expectations.

Mission:

- To provide top-tier technical education in Computer Applications and Information Technology, guided by strong values and supported by cutting-edge infrastructure and innovative methods.
- To foster ethical, ambitious, and skilled engineers through a balanced approach of theoretical knowledge and practical experience.
- To develop the ability to solve both simple and complex challenges individually and in teams.
- To nurture globally competitive engineers with solid foundations, encouraging innovative thinking to navigate dynamic changes and advocate for environmentally conscious green computing solutions.

Programme Educational Objectives (PEOs)

PEO1: Graduates will be equipped with the prequalification for professionals heading for a smart career in the IT field, which measures up to industry standards.

PEO2: Graduates will demonstrate the knowledge to analyze, design and code software applications.

PEO3: Graduates will be competent with the ability to understand the concepts of logic development, best software practices used in industry.

PEO4: Graduates will be proficient to gain an opportunity for Higher education in esteemed institutions/Academic Research centers.

Programme Outcomes (POs)

Graduates will be able to:

PO1: Knowledge: Apply the knowledge of data science, mathematics and computer science specialization to analyze and solve problems.

PO2: **Problem analysis:** Identify, formulate and analyze complex problems and find simple solutions

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

PO4: Modern tool usage: Create, select and apply appropriate techniques, resources and IT tools.

PO5: Environment and Sustainability: Understand the impact of the professional solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.

PO6: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms in the field of technology.

PO7: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO8: Communication: Communicate effectively on activities with the society at large, such as, being able to make effective presentations, and give and receive clear instructions.

PO9:Project management and finance: Demonstrate knowledge and understanding of data science and computer science principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO10: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

Graduates will be able to:

PSO1: Develop core competence in data science, mathematics and computer science to address ever-changing industrial requirements globally.

PSO2: Develop sustainable solutions for society.

PSO3: Become a skilled data scientist to meet industry standards.

PSO4: Develop domain-specific software tools for data storage, analysis and visualization.

PSO5: Able to independently carry out research/investigation to solve practical problems

Credit Structure

Sl. No	Category	I Sem	II Sem	III Sem	IV Sem	Total Credits
1	Core Course (Major)	16	16	16	5	53
2	Discipline Specific Elective	6	6	6	6	24
3	MOOC- Major	-	-	4	-	4
4	Internships	-	-	-	6	6
5	Capstone Project / Dissertation	-	-	-	6	6
6	Research Publication	-	-	-	1	1
7	Community Services				2	2
	Total Credits	22	22	26	26	**96**

Programme Structure

LEGEND	
UGC	
CC	Core Course
AECC	Ability Enhancement Compulsory Course
SEC	Skill Enhancement Course
GE	General Elective
DSE	Discipline Specific Elective
CMRU	
FC	Fundamental Course
IC	Intermediate Course
AC	Advanced Course
IDE	Interdisciplinary Elective
Common Core Courses	
PS	Preparing for Success
KSC	Knowing Self & Community
CS	Contributing to Society
AECC	Ability Enhancement Compulsory Course
SEC	Skill Enhancement Course

COURSE CODE DESCRIPTION:

aXXXX bccd:

a - School Code Number

1 - School of Education (SOE)
2 - School of Architecture (SOA)
3 - School of Economics & Commerce (SOEC)
4 - School of Engineering & Technology (SOET)
5 - School of Legal Studies (SOLS)
6 - School of Management (SOM)
7 - School of Social Sciences & Humanities (SOSSH)
8 - School of Science and Computer Studies (SSCS)
9 - School of Design (SOD)
C - Department of Common Core Curriculum (DCCC)

XXXX - Discipline Code
b - Level Number
cc - Course Number
d - Syllabus Version Number

PROGRAM CORE DISCIPLINE CODE:

DISCIPLINE	CODE
General Computer Science	CSGC
Programming Languages	CSPL
Artificial Intelligence	CSAI
Data Science	CSDS
Cloud Computing	CSCC
Game Development	CSGA
Visual Effects & Animation	VEAA
Game Art & Design	GAAD
Art & Graphic Study	AAGS
Media Studies	MEST
Sound Engineering	SOEN
Film Making	FIMA
Photography	PHGY
Statistics	STAT
Research	RESE
Mathematics	MATH
Internship	INTS
Capstone	CAPS
Massive Open Online Courses	MOOC
Interdisciplinary Courses	IDSS

COMMON CORE DISCIPLINE CODE:

DISCIPLINE	CODE
Contributing to Society - Ability Enhancement Compulsory Course	CSAE
Knowing Self & Community - Ability Enhancement Compulsory Course - Arts & Philosophy	KSAA
Knowing Self & Community - Ability Enhancement Compulsory Course - Me, My Country & My World	KSAM
Preparing for Success - Ability Enhancement Compulsory Course - Design Thinking	PSAD
Preparing for Success - Ability Enhancement Compulsory Course	PSAE
Preparing for Success - Ability Enhancement Compulsory Course - Language	PSAL
Preparing for Success - Skill Enhancement Course	PSSE
Preparing for Success - Skill Enhancement Course - Foreign Language	PSSF
Preparing for Success - Skill Enhancement Course - NCC	PSSN

CREDIT DISTRIBUTION:

L-T-P-C :

L - Lecture credits
T - Tutorial credits
P - Practical credits
C - Credit (Total)

STE 2024-26

School of Science and Computer Studies

Master of Science IT in Data Science

I Semester

Sl. No.	Course Code	Course	CMRU Category	CMRU Sub category	UGC category	School	Contact Hours/ Week	Credit Distribution L-T-P-C
1	8CSGC5591	Relational Database Management Systems with PL/SQL and Lab	Foundation	FC	CC	SSCS	7	3-0-2-5
2	8CSPL5461	Python and R Programming and Lab	Foundation	IC	CC	SSCS	7	3-0-2-5
3	8CSDS5221	Principles of Data Science	Foundation	IC	CC	SSCS	3	3-0-0-3
4	8STAT5041	Probability and Statistics	Foundation	IC	CC	SSCS	3	3-0-0-3
5	8CSGC6741 / 8CSGC5751	**Elective 1 :** Computer Network and Security/ Distributed Computing	Discipline Specific Elective	IC	DSE	SSCS	3	3-0-0-3
6	8CSGC5281 / 8CSGC5231	**Elective 2:** Advanced Algorithms/ Object-Oriented Modeling and Design	Discipline Specific Elective	AC	DSE	SSCS	3	3-0-0-3
	GCSCD1011	Community Service Programme - I (COS- I)*	CS	-	-	DCCC	(30)	0-0-1-1*
	Total							**22+1***
Common Core (Non Credit) - Graduate Requirement:								-

7	GPSBD1111	Communicative Skills in Digital Era	PS	GR	AECC	DCCC	2	
8	GPSBD1171 GPSBA1121	Career Essentials Prepare for Aptitude Tests - I	PS	GR	AECC	DCCC	1 2	

Internship- I (CIP) of 2 credits to be carried out between I and I Semester break. The corresponding 2 credits will be reflected in the IV Semester.

School of Science and Computer Studies

Master of Science IT in Data Science

II Semester

Sl. No.	Course Code	Course	CMRU Category	CMRU Sub category	UGC category	School	Contact Hours/ Week	Credit Distribution L-T-P-C
1	8CSAI6131	Artificial Intelligence and Lab	Foundation	IC	CC	SSCS	7	3-0-2-5
2	8CSAI6141	Internet of Things and Lab	Foundation	AC	CC	SSCS	7	3-0-2-5
3	8CSCC6201	Advanced Cloud Computing	Foundation (INDUSTRY EXPERT/POP)	AC	CC	SSCS	3	3-0-0-3
4	8CSGC6241	Software Project Management	Foundation	AC	CC	SSCS	3	3-0-0-3
5	8CSGC6431 / 8CSDS6291	**Elective 3:** Optimization Techniques/ Multivariate Data Analysis	Discipline Specific Elective	DSE	Elective	SSCS	3	3-0-0-3
6	8CSDS5251 / 8CSGC6771	**Elective 4:** Deep Learning / Data Mining	Discipline Specific Elective	DSE	Elective	SSCS	3	3-0-0-3
	8INTS6010	Internship I† (CIP)	Foundation	Internship	CC		30	

	GCSCD1021	Community Service Programme - II (COS-II)*	CS	-	-		(30)	0-0-1-1*
	Total							**22 +1***
Common Core (Non Credit) - Graduate Requirement:								-
7	GPSBT1041	Design Thinking	PS	GR	AECC	DCCC	(30)	
8	GPSBD1181 GPSBA1122	Career Effectiveness Prepare for Aptitude Tests - II	PS	GR	AECC	DCCC	3	

† Internship I - Community Internship Program (CIP) credits are reflected in the IV Semester
Internship- II (SIP) of 4 credits to be carried out between II and III Semester break. The corresponding 4 credits will be reflected in the IV Semester.

***The Community Service Programme -II (COS-II) of 30 hours has to be carried out in the II Semester. The corresponding 1 credit and the CIE will be reflected in the IV Semester.**

School of Science and Computer Studies

Master of Science IT in Data Science

III Semester

Sl. No.	Course Code	Course	CMRU Category	CMRU subcategory	UGC Category	school	Contact Hours/ Week	Credit Distribution L-T-P-C
1	8CSDS6201	Machine Learning using Python and Lab	Foundation	AC	CC	SSCS	7	3-0-2-5
2	8CSDS6261	Data Visualization using PowerBI and Tableau and Lab	Foundation	AC	CC	SSCS	7	3-0-2-5
3	8RESE6031	Quantitative Research Methodology	Multidisciplinary	MDC	MDC	SSCS	3	3-0-0-3
	8CSAI6181	Knowledge Engineering	Foundation	AC	CC	SSCS	3	3-0-0-3
4	8CSAI6161 / 8CSGC6781 / 8CSDS6271	**Elective 5:** Natural Language Processing Techniques /Digital Marketing Analytics/ Predictive Analytics	Discipline Specific Elective	DSE	Elective	SSCS	3	3-0-0-3

5	8CSAI6171 / 8CSGC6791	**Elective 6:** Virtual Reality and Augmented Reality / Digital Forensic	Discipline Specific Elective	DSE	Elective	SSCS	3	3-0-0-3
6	8MOOC1XX1	MOOC	Foundation			-		4-0-0-4
	8INTS7010	Internship I†† (SIP)	Foundation	Internship	CC	SSCS		
							26	**26**
	Common Core (Non Credit) - Graduate Requirement:							
7	GPSDL1051	**Career Preparedness Courses:** Career Preparedness Program -3 (Strategies for Self-management (SSM)	CC	GR	AECC	DCCC	1	-

† Internship II - Summer Internship Program (SIP) credits are reflected in the IV Semester

STE 2024-26

School of Science and Computer Studies

Master of Science IT in Data Science

IV Semester

Sl. No.	Course Code	Course	CMRU Category	CMRU subcategory	UGC Category	school	Contact Hours/ Week	Credit Distribution L-T-P-C
1	8CSDS5231	Big Data Analytics using Hadoop and Lab	Foundation (INDUSTRY EXPERT/POP)	AC	CC	SSCS	7	3-0-2-5
2	8CSGC6311 /8CSGC6331	**Elective 7:** Blockchain Technology/Digital Image Processing	Discipline Specific Elective (INDUSTRY FACING MODULE)	DSE	CC	SSCS	3	3-0-0-3
3	8CSCC6131/ 8CSGC6361	**Elective 8:** Cloud Security/Wireless Sensor Networks	Discipline Specific Elective (INDUSTRY FACING MODULE)	DSE	EC	SOSS	3	3-0-0-3
4	8INTS6010	Internship-1 (CIP)	Foundation	Internship	CC		30	0-0-2-2
5	8INTS7010	Internship-2 (SIP)	Foundation	Internship	CC		2 months	0-0-4-4
6	6CAPS7010	Capstone Project	Foundation	captones	DSE	SSCS		0-0-6-6
	8RESE6021	Research Publication			DSE	SSCS		1
8	GCSCD1011	Community Service Programme - I (COS- I)*	CS	-	-	DCCC	(30)	0-0-1-1

9	GCSCD1021	Community Service Programme - II(COS- II)*	CS	-	-	DCCC	(30)	0-0-1-1
	Total							**26**

Paper Publication Scopus Indexed/Web of Science or equivalent esteemed journals

† The credits of Internship I - Community Internship Program (CIP) taken up after the I Semester is reflected in the IV Semester

†† The credits of Internship II - - Summer Internship Program (SIP) taken up after the II Semester is reflected in the IV Semester

COMMON CORE (NON-CREDIT): GRADUATE REQUIREMENT

***Career Preparedness: Discover-Build-Deliver (DBD) Modules**

Career Preparedness	Semester
Build (common) - Create a resume	I
Build (common) - Preparing for internship (a)	I
Build (common) - Develop social and emotional intelligence	I
Build (common) - Prepare for aptitude tests (only training)	I - II
Build (common) - Choose the right mentors	II
Build (common) - Understand your digital footprints	II
Build (common) - Finding the right internship	II
Build (work track) - Prepare for case studies	II
Build (work track) - Prepare for interviews and GDs	II
Build (Entrepreneurship track)	II
Build (Research track)	II
Build (common) - Preparing for internship (b)	II
Build (work track) - Prepare for career fair	III
Deliver - Build your resume and cover letter	III
Deliver - Establish your personal brand	III
Deliver - Develop financial literacy	III

Deliver - Manage your personal and professional growth	III
Deliver - Placement / Final Internship	IV

****Community Service**

Mandatory Community Service	Semester
Social Impact Leadership Summit	I Semester
Community Service Activities	I to III Semester
Reflective Conclave	IV Semester
Total hours of Community Service: 75 hours (25 hours per Semester)Deficit of Community Service Hours in a particular semester has to be completed in the subsequent semester on obtaining prior permission from the Dean/Director of the School	

First Semester Syllabus

8STAT5041: PROBABILITY AND STATISTICS		
A: Course Framework		
Credits: L-T-P-C: 3-0-0-3		**Syllabus Version: 1**
Contact Hours/Week: 3	**Total Contact Hours: 45**	**Level: 500**
Prerequisite:(If applicable)	Learners must be familiar with Basic Mathematics.	
Course Learning Objectives		
CLO1: To understand fundamental concepts of descriptive statistics **CLO2**: To understand and apply probability and statistics techniques in the field of business analytics, machine learning and other domains. **CLO3** : To understand various statistical distributions **CLO4**- To understand basic concepts of statistical inferences		
Course Outcomes: On successful completion of the course, Students will be able to,		
CO1: Represent data, apply/formulate the concepts and theories of measures of central tendency and Dispersion in the functional areas of business and research. (L3) **CO2**:To forecast the data based on past data, to analyze the relationship and the degree of association between two variables.(L4) **CO3**: Calculate probabilities by applying probability laws and theoretical results.(L3) **CO4**: To understand the role of sampling techniques when large amounts of data are involved.(L2) **CO5**: Explain the role of probability in hypothesis testing and describe issues related to interpreting statistical significance.(L3)		
PO: PO1/PO2		**PSO**: PSO1/PSO2
B: Syllabus		

Module 1: Introduction to Statistics, Measures of Central Tendency and Dispersion Hours : 9
Introduction: Definition, Characteristics of Statistics, Functions of Statistics, Scope of Statistics, Limitations of Statistics. **Measures of Central Tendency:** Mean, Median and Mode-examples. Partition values-Quartiles, Deciles and Percentiles. **Measures of Dispersion:** Range, Quartile deviation, Mean deviation, Standard deviation and their relative measures. Skewness, Kurtosis
Module 2: Correlation and Regression, Time Series Hours : 9
Time series : Definition- Components of Time series. **Trend analysis:** Least Square method. **Correlation:** Meaning and types of correlation, Karl Pearson and Spearman rank correlation **Regression:** Meaning, Regression equations and their application
Module 3: Probability and Distributions Hours : 9
Probability-Meaning and Basic concepts, Laws of probability, Addition theorem, Multiplication theorem, Conditional Probability. Bayes theorem and its applications. **Random Variable, Expectation and Probability Distributions.** Discrete and continuous random variable, Binomial, Poisson and Normal distributions.
Module 4: Introduction to Sampling Techniques Hours : 9
Sampling: Population and Sample, Types of Sampling, Introduction to sampling distributions, sampling distribution of mean and proportion, Sampling techniques, Estimation: Point and Interval estimates for population parameters of large sample and small samples determining the sample size.
Module 5 : Hypothesis Testing Hours: 9
Hypothesis Testing: Formulation of Hypotheses**,** Null and alternative hypothesis, Type I and type II errors, one and two tailed tests, Test of significance- single mean, difference of means, Confidence interval -1% and 5% level of significance. **Small sample tests** – t test-for single mean, difference of means, Chi-square test, F-test for equality of two population variances.
C : References

1. Gupta S C,"Fundamentals of Statistics", Himalaya Publishing House, 6th edition,2018
2. Murray R Spiegel,Larry J Stephens,"Schaum's outlines of Statistics, Tata Mcgraw Hill, 3rd Edition,2009
3. Sharma J K," Business Statistics", Pearson Education India, 2006
4. Levin and Rubin,"Statistics for Management",Pearson, 7th Edition
5. Agarwal B. C, "Basic Statistics",New age International, 2006

D: Mode of Assessment

IAT / CCE / SEE

E. Scheme of Evaluation

1. Continuous Internal Evaluation (CIE) : 50 Marks

Components	Average of 2 IAT's	CCE	Total Marks
Max. Marks	20	30	50

2. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L1, L2, L3
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	PO										PSO				
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5
1	*	*									*	*			
2	*	*									*	*			
3	*	*									*	*			
4	*	*									*	*			
5	*	*									*	*			

8CSDS5221: PRINCIPLES OF DATA SCIENCE		
A: Course Framework		
Credits: L-T-P-C: 3-0-0-3		**Syllabus Version: 1**
Contact Hours/Week: 3	**Total Contact Hours: 45**	**Level: 600**
Prerequisite:(If applicable)	Knowledge about Fundamentals of Database Management Systems.	
Course Learning Objectives		
CLO1: To provide a strong foundation for data science and its application area. **CLO2**: To understand the underlying core concepts and emerging technologies in data science. **CLO3** : To develop applied experience with data science software, programming, applications and processes. **CLO4**- To develop practical skills needed in modern analytics.		
Course Outcomes: On successful completion of the course, Students will be able to,		
CO1: Apply the fundamental concepts of data science(L3) **CO2**: Apply Data analysis techniques for applications handling large data(L4) **CO3**: Understand various machine learning algorithms used in data science process(L2) **CO4**: Visualize and present the inference using various tools (L3) **CO5**: Create ethics surrounding privacy, data sharing and algorithmic decision making (L4)		
PO: PO1/PO2/PO3/PO4/PO6		**PSO**: PSO1/PSO2/PSO4
B: Syllabus		
Module 1: Introduction to Data Science		**Hours : 9**

Introduction: Definition – Basic Terminology- Data science Venn diagram- Types of Data- Structured versus Unstructured data- Quantitative versus Qualitative data- The Four Levels of Data- Five steps of Data Science- Data Science Process Overview –Data science classification-Data Science Algorithms- Business Intelligence and Data Science- Components of Data Science.

Module 2: Data Process and Exploration **Hours : 9**

Introduction-Prior Knowledge-Data Preparation-Modeling-Applications-Objectives of Data Exploration-Datasets-Descriptive statistics- Data Visualization: Introduction- Types of Data visualization- Technologies for visualization - Various visualization techniques - The Five Cs of Data Visualization.

Module 3: Data Modelling and Analytics **Hours : 9**

Probability-Meaning and Basic concepts, Laws of probability, Addition theorem, Multiplication theorem, Conditional Probability. Bayes theorem and its applications.

Random Variable, Expectation and Probability Distributions. Discrete and continuous random variable, Binomial, Poisson and Normal distributions.

Module 4: Feature selection and forecasting **Hours : 9**

Sampling: Population and Sample, Types of Sampling, Introduction to sampling distributions, sampling distribution of mean and proportion, Sampling techniques, Estimation: Point and Interval estimates for population parameters of large sample and small samples determining the sample size.

Module 5 : Data Science Tools and Applications **Hours: 9**

Hypothesis Testing: Formulation of Hypotheses**,** Null and alternative hypothesis, Type I and type II errors, one and two tailed tests, Test of significance- single mean, difference of means, Confidence interval -1% and 5% level of significance.

Small sample tests – t test-for single mean, difference of means, Chi-square test, F-test for equality of two population variances.

C : References

1 Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, Fundamentals of Data Science, 1 st Edition, 2022

2 Daimi, Kevin, Ed. Hamid R. Arabnia, Principles of Data Science, Springer, 2020.

3 Vijay Kotu, Bala Deshpande, Data Science: Concepts and Practices, Morgan Kaufmann Publishers, Second edition, 2019

4 D J Patil, Hilary Mason, Mike Loukides, Ethics and Data Science, O' Reilly, 1st edition, 2018

5 Sinan Ozdemir, Principles of Data Science, Packt Publishing, December 2016
D: Mode of Assessment
IAT / CCE / SEE
E. Scheme of Evaluation

1. Continuous Internal Evaluation (CIE) : 50 Marks

Components	Average of 2 IAT's	CCE	Total Marks
Max. Marks	20	30	50

2. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L1, L2, L3
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
	PO										PSO				
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5

CO															
1	*	*									*	*			
2	*	*	*								*	*			
3	*	*									*	*			
4	*	*		*							*	*		*	
5	*	*				*					*	*			

8CSG5591: RELATIONAL DATABASE MANAGEMENT SYSTEM WITH PL/SQL		
A: Course Framework		
Credits: L-T-P-C: 3-0-2-5		**Syllabus Version: 1**
Contact Hours/Week: 7	**Total Contact Hours: 105**	**Level: 500**
Prerequisite:(If applicable)	Knowledge about Fundamentals of Database Management Systems.	
Course Learning Objectives		
CLO1: To provide understanding of three levels of Database Architecture and Relational database management system. **CLO2**: To provide understanding on Integrity rules, Aggregation, generalization and Specification with Normalization **CLO3**: To provide understanding on ER- Model and Transfer to physical database **CLO4**: To provide understanding on SQL and Advanced SQL Management **CLO5**: To provide understanding on Transaction Management system with concurrency problems **CLO6:** To provide understanding on Concurrency and recovery system of the database		
Course Outcomes: On successful completion of the course, Students will be able to,		
CO1: Design three levels of Database Architecture and Relational database management system.(L3) **CO2**: Apply Integrity rules, Aggregation, generalization and Specification with Normalization (L3) **CO3**: Design ER- Model and Transfer to physical database (L4) **CO4**: Write simple SQL queries, create PL/SQL blocks, create procedures, functions, cursor, trigger (L2) **CO5**: Design Transaction Management system with concurrency problems (L4) **CO6:** Analyze Concurrency and recovery system of the database (L4)		
PO: PO1/PO2 /PO3/PO6		**PSO**: PSO1/PSO2
B: Syllabus		

Module 1: Introduction to the Relational Model **Hours : 9**
Introduction Database-system Application, Purpose of Database System, View of Data , Database Languages, Relational Database, Database Design, Data Storage and Query ,Database Users and Administrator, History of Database Systems, Structure of Relational Databases, Database Schema, Keys, Schema Diagrams, Relational Query Languages, Relational Operations
Module 2: Structured Query Language **Hours : 9**
Overview of the SQL Query Language SQL Data Definition, Basic Structure of SQL Queries , Additional Basic Operations, Set Operations, Aggregate Functions, Nested Sub queries**,** String functions, Mathematical functions, Time and Date functions
Module 3: Advanced SQL **Hours : 9**
Intermediate SQL Join Expressions, Views ,Transactions, Integrity Constraints, SQL Data Types and Schemas, Authorization **Advanced SQL** Accessing SQL from a Programming Language, loop and conditional statements, Cursor, Parameterized cursor, Implicit and Explicit cursor, Functions and Procedures, Triggers ,Advanced Aggregation Features
Module 4: Database Design and the E-R Model **Hours : 9**
Overview of the Design Process , The Entity-Relationship Model, Constraint, Removing Redundant Attributes in Entity Sets, Entity-Relationship Diagrams, Entity-Relationship Design Issues. **Extended E-R Features** Alternative Notations for Modeling Data, Other Aspects of Database Design **Relational Database Design** Features of Good Relational Designs, Atomic Domains and First Normal Form ,Decomposition Using Functional Dependencies, Functional-Dependency Theory ,Algorithms for Decomposition, Decomposition using multivalued Dependencies, Third Normal Form, Fourth Normal Form, Fifth Normal Form, BCNF, Database-Design Process
Module 5 : Transactions, Concurrency Control, Recovery **Hours: 9**
Transactions Transaction Concept, Simple Transaction Model, Transaction Atomicity and Durability, Transaction Isolation , Serializability, Transaction Isolation and Atomicity ,Validation-Based Protocols, Snapshot Isolation **Concurrency Control** Lock-Based Protocols, Deadlock Handling , Multiple Granularities, Timestamp-Based Protocols **Recovery System** Failure Classification, Recovery and Atomicity, Recovery Algorithm, Buffer Management
Part- A

1. Basic Database Operations

1. Create tables according to the following definition.

Create Table Job (job_id, job_title, min_sal, max_sal), job_id Varchar2(15), job_title Varchar2(30), min_sal Number(7,2), max_sal Number(7,2)

Create table Employee (emp_no, emp_name, emp_sal, emp_comm,dept_no) emp_no Number(3), emp_name Varchar2(30), emp_sal Number(8,2), emp_comm Number(6,1), dept_no Number(3)

Create table deposit(a_no,cname,name,amount,a_date), a_no Varchar2(5), cname Varchar2(15), bname Varchar2(10), amount Number(7,2), a_date Date

Create table borrow(loanno,cname,bname,amount). loanno Varchar2(5), cname Varchar2(15), bname Varchar2(10), amount Varchar2(7,2)

2. Insert values into the above tables

3. Perform following queries

a) Retrieve all data from employee, jobs and deposit.

b) Give details of account no. and deposited rupees of customers having account opened between dates 01-01-06 and 25-07-06.

c) Display all jobs with minimum salary greater than 4000.

d) Display name and salary of employee whose department no is 20.
Give alias name to name of employee.

e) Display employee no,name and department details of those employee whose department lies in(10,20)

2. To study various options of LIKE predicate.

a) Display all employees whose name start with 'A' and the third character is 'a'.

b) Display name, number and salary of those employees whose name is 5 characters long and first three characters are 'Ani'.

c) Display the non-null values of employees and also employee name second character should be 'n' and string should be 5 character long.

d) Display the null values of employee and also employee name's third character should be 'a'.

e) What will be output if you are giving LIKE predicate as '%_%' ESCAPE '\'

3. To perform various data manipulation commands, aggregate functions and sorting concept on all created tables.

a) Insert a new column "Balance" of integer type and "Account" of varchar2(30) type in the customers table.

b) Update the balance of “Anil” to 10000

c) Update the balance of “Pramod” to 20000 and Account to “Savings”

d) Update the balance of “Naren” to 30000 and Account to “Current”

e) Rename column “Balance” to “Bal” in customers table

f) Change the datatype of “Bal” to varchar2

g) Delete the columns Bal and Account.

h) List total deposit from deposit.

i) List total loan from karolbagh branch

j) Give maximum loan from branch vrce.

k) Count total number of customers

l) Count the total number of customer’s cities.

m) Create table supplier from employee with all the columns.

n) Create table sup1 from employee with the first two columns.

o) Create table sup2 from employee with no data

p) Insert the data into sup2 from the employee whose second character should be ‘n’ and the string should be 5 characters long in the employee name field.

q) Delete all the rows from sup1.

r) Delete the details of the supplier whose emp_no is 103.

s) Rename the table sup2.

t) Destroy table sup1 with all the data.

u) Update the value dept_no to 10 where the second character of emp name is ‘m’.

v) Update the value of employee name to ‘Niyati’ whose employee number is 103

4. To study single-row functions.

a) Write a query to display the current date. Label the column Date

b) For each employee, display the employee number, job, salary, and salary increased by 15% and expressed as a whole number.

Label the column New Salary

c) Modify your query no 11. (b) to add a column that subtracts the old salary from the new salary. Label the column Increase

d) Write a query that displays the employee's names with the first letter capitalized and all other letters lowercase, and the length of the names, for all employees whose name starts with J, A, or M.

Give each column an appropriate label. Sort the results by the employee name.

e) Write a query that produces the following for each employee:

a. <employee name> earns <salary> monthly

f) Add hiredate field in employee table and add following values in it

emp_no emp_name hiredate

101 Smith 01-jan-06

102 Snehal 07-jun-07

103 Adama 08-aug-10

104 Aman 02-mar-05

105 Anita 09-sep-12

106 Sneha 13-oct-15

107 Anamika 22-jan-20

g) Display the name, hire date, number of months employed and day of the week on which the employee has started. Order the results by the day of the week starting with Sunday.

h) Display the hiredate of emp in a format that appears as 7th of June 1994.

i) Write a query to calculate the annual compensation of all employees (sal+comm.).

5. Displaying data from Multiple Tables (join)

a) Change the city of 'ANIL' in customers table to 'NAGPUR'.

b) Give all the details of customers ANIL by joining deposit, customer, and branch tables.

c) Give name of customer who are borrowers and depositors living in NAGPUR.

d) Give the city of customers living in the same city as their branch.

e) Create a table Department with fields dept_no number(8), dept_name varchar2(30), dept_city varchar2(30) and insert following records

dept_no dept_name dept_city

10 MARKETING JAIPUR

15 HR NAGPUR

20 FINANCE BOMBAY

25 OPERATIONS DELHI

30 IT AHMEDABAD

f) Write a query to display the name, department number, and department name for all employees.

g) Add a new field dept_no in the table job and insert following values in the table job.

job_id job_title dept_no

IT_PROG Programmer 30

MK_MGR Marketing manager 10

FI_MGR Finance manager 20

FI_ACC Account 20

LEC Lecturer 25

COMP_OP Computer Operator 30

h) Create a unique listing of all jobs that are in department 20. Include the location of the department in the output

i) Write a query to display the employee name, department number, and department name for all employees who work in JAIPUR.

j) Add Mgr_No field in employee table and add following values in it

emp_no emp_name Mgr_No

101 Smith 101

102 Snehal 107

103 Adama 107

104 Aman 106

105 Anita 106

106 Sneha 102

107 Anamika 101

k) Display the employee name and employee number along with their manager's name and manager number. Label the columns

Employee, Emp#, Manager, and Mgr#, respectively

6, To apply the concept of Aggregating Data using Group functions.

a) List total deposit of customer having account date after 1-jan-96.

b) List total deposits of customers living in city Nagpur.

c) List maximum deposit of customers living in Bombay.

d) Display the highest, lowest, sum, and average salary of all employees. Label the columns Maximum, Minimum, Sum, and Average, respectively. Round your results to the nearest whole number.

e) Write a query that displays the difference between the highest and lowest salaries. Label the column DIFFERENCE.

f) Create a query that will display the total number of employees hired between 2010 and 2020

g) Find the average salaries for each department without displaying the respective department numbers.

h) Write a query to display the total salary being paid to each job title, within each department.

i) Write a query to display the department names having average salaries > 2000 without displaying the respective department numbers.

j) Display the job and total salary for each job with a total salary amount exceeding 3000, in which excludes Marketing Manager and sorts the list by the total salary

k) List the branches having sum of deposit more than 5000 and located in city Bombay

7. To solve queries using the concept of sub query.

a) Write a query to display the employee name and hiredate for all employees in the same department as Smith. Exclude Smith.

b) Create a query to display the employee number and name for all employees who earn more than the average salary. Sort the results in descending order of salary.

c) Write a query to display the employee number and name for all employees who work in a department with any employee whose name contains a t.

d) Display the employee name, department number, and department name for all employees whose department location is Jaipur. e) Display the employee name and salary of all employees who report to Anamika.

f) Display the department number, name, and salary for all employees in the Finance department.

g) Modify 14(c) to display the employee number, name, and salary for all employees who earn more than the average salary and who work in a department with any employee with a t in their name.

8. Manipulating Data

a) Give 10% interest to all depositors.

b) Give 10% interest to all depositors having branch vrce

c) Give 10% interest to all depositors living in Nagpur or Bombay.

d) Transfer 10 Rs from account of anil to sunil if both are having same branch.

e) Delete depositors of branches having number of customers between 1 and 3.

f) Delete deposit of vijay.

g) Delete borrower of branches having average loan less than 1000

9.TCL commands

Give examples of TCL commands - COMMIT, ROLLBACK, and SAVEPOINT command with the help of transactions in SQL

10. Write a PLSQL block

To print Employee list (Empno and Name) EMP (empno, empnm, empadd, salary, date_birth, joindt, deptnoid)

11. Write a function

To display the number of items whose weight fall between a given ranges for a particular color using table ITEM (itemno, name, color, weight)

Write a function to display minimum of two numbers(23,45)

12. Write a procedure

To display top five highest paid workers who are specialized in ‘PAINTING" using table WORKER (workerid, name, wage_per_hour,specialized_in, manager_id)

13. Create or replace trigger

For table Job (job_id, job_title, min_sal, max_sal), job_id Varchar2(15), job_title Varchar2(30), min_sal Number(7,2), max_sal Number(7,2) before update or delete on salary for each row

14.Employee (eid, fname, lname, salary)

a) Use a Cursor for Loop inside a function to calculate and return total paid salary to all employees by the company.

b) Modify the function created above to become a procedure and display the total paid salary from the procedure itself. Instead of calculating for all employees, calculate only for those employees whose name starts from a character passed as parameter to the procedure and hence to the cursor

Part B

Mini Project

1. Develop a mini project which works on backend using SQLPLUS and PL/SQL with normalized database up to 3NF for any of the following sector

A. Banking application -

i. account opening for Savings Account, Current Account, and RD Account,

ii. perform withdrawal and deposit to account

iii. generate mini statement of 10 transactions

iv. generate statement for the between start and end dates

B. Library Management

i. store all books procured by college

ii. create accounts for staff and students

iii. perform transactions such as withdraw and return of books

iv. collect fine if books is returned after due date

v. generate report based on author, publisher, category

vi. generate monthly usage report of students and staffs

vii. generate regular defaulters who return books after due date

C. Hospital Management

i. Store all patient ,Doctor and ward details

ii.Maintain Medical records of the Patient

iii.Keep track of appointment dates

iv. Save the Insurance Details of the Patient

v Tracking of Bill Payments

D. Hotel Management

i.Store all customer,room and employee details

ii.Maintain Housekeeping data

iii. Keep track of Hotel reservation details

iv.Generate the Room rent Bill

C : References

1. Silberschatz, H.F. Korth, S. Sudarshan, Database System Concepts 6th Edition, McGraw
2. Hill, 2010.R. Elmasri, S.B. Navathe, Fundamentals of Database Systems 6th Edition, Pearson Education, 2010.
3. R. Ramakrishanan, J. Gehrke, Database Management Systems 3rd Edition, McGraw-Hill, 2002.
4. R. Elmasri, S.B. Navathe Database Systems Models, Languages, Design and application Programming, 6th Edition, Pearson Education, 2013.

D: Mode of Assessment

IAT / CCE / SEE

E. Scheme of Evaluation

1. (a).Continuous Internal Evaluation(CIE): 100 Marks

Components	Sum of 3 IATs	CCE	Practical Exam	Total Marks
Max. Marks	30 (Theory-2, Practical – 1)	20 (Theory-2, Practical – 1)	50	100
Theory	20	10		
Practical	10	10		

(b) Practical Exam : 50 Marks

Section	Course with project	Course without project	Total Marks for the Section	Revised Bloom's Taxonomy
Writing Program & Abstract	2 Programs & Project Abstract (10+5)	2 Programs	15	L3
Execution	1 Program & Project Demo (10+10)	2 Programs	20	L4
Viva-Voce	10	10	10	L5
Record/Report	5	5	5	

2. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L1, L2, L3

B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	**PO**										**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**
1	*	*	*								*	*			
2	*	*	*								*	*			
3	*	*	*								*	*			
4	*	*									*	*			
5	*	*	*			*					*	*			
6	*	*	*			*					*	*			

8CSPL5461: PYTHON AND R PROGRAMMING

. Course Framework

Credits: L-T-P-C: 3-0-2-5		**Syllabus Version: 1**
Contact Hours / Week: 7	**Total Contact Hours: 105**	**Level: 500**
Prerequisite : (If applicable)	Basic concepts of programming languages	

Course Learning Objectives:

CLO1: To understand how to write and execute simple Python programs
CLO2: To Learn the conditionals, lists and classes in python

CLO3: TO understand the data visualization in python

CLO4: Understand how to demonstrate simple R programs

CLO5: Familiarize yourself with data visualization in R.

Course Outcomes: On successful completion of the course, Students will be able to,

CO1:. Write python programs for different problems (L2)
CO2: Analyze the real-life problems and solve using python programming (L4)

CO3: Apply data visualization for real time problems in python (L4)

CO4: Write R programs and for different real life problems (L4)

CO5: Create programs for appropriate problems using data visualization with R (L4)

PO: PO1-PO4/P6-PO10 **PSO**: PSO1-PSO5

B. Syllabus

Module 1: INTRODUCTION TO PYTHON Hours: 9

Introduction to Python – Features of Python – Variables, Expressions and Statements – Order of operations – String operations - Functions – Flow of execution – Parameters and arguments.Loops and Decision Making, Functions and Basic OOPs Concept.

Module 2: CONDITIONALS, LISTS, CLASSES Hours: 9

Conditionals and Recursion – Boolean expressions – Logical operators – Chained and Nested conditionals – Recursion - Iteration – Strings – Lists – Dictionaries – Tuples – Files – Classes and Objects.

Python Modules and Packages, Advance Python Decorator, Iterator and Generator Anonymous Function and SQL and Python,Errors and Exception Handling .

Module 3: NUMPY, PANDAS, MATPLOTLIB Hours: 9

The basics of NumPy arrays – Computation on NumPy Arrays : Universal Functions – Aggregations - Broadcasting – Comparisons, Masks and Boolean logic – Fancy Indexing – Sorting Arrays – Structured Data - Data Manipulation with Pandas – Introducing Panda Objects – Data Indexing and Selection – Operating on Data in Pandas – Handling Missing Data – Hierarchical Indexing – Working with Time Series – High Performance Pandas – Visualization with Matplotlib- Simple Line Plots – Simple

Scatter Plots – Visualizing Errors - Density and Contour Plots – Histograms, Binning and Density – Three Dimensional plotting in Matplotlib – Visualization with Seaborn.

Module 4:INTRODUCTION TO R **Hours: 9**

Basics of R – Vectors – Operations – Filtering - Matrices and Arrays – Matrix Operations - Lists – List Operations – List Components and values - Data Frames – Creation and Merging - Tables – Structures – Control Structures – Functions – Recursions.

Module:5: DATA VISUALIZATION WITH R **Hours: 9**

Data Visualization with ggplot2 – aesthetic mappings - geometric objects – statistical transformations – coordinate systems - Data transformation with dplyr – Exploratory data analysis – missing values – co variation – patterns and models – ggplot2 calls.

PART A (Python Programming)

1. Write a program to check if given array is Monotonic
2. Write a program for Sum of squares of first n natural numbers
3. Write a Program to Perform basic computations on NumPy arrays using universal functions and demonstrate array aggregations.
4. Write a program to understand broadcasting rules and use masks with boolean logic in NumPy..
5. Write a program to introduce basic operations and data manipulation techniques using Pandas
6. Write a program to Utilize Matplotlib and Seaborn to create various types of visualizations.

PART B (R programming)

1.Write a R program to get the first 10 Fibonacci numbers. ii.Generate the following:
   a. Access the element at 3rd column and 1st row in a matrix.
   b. Access only the second row
   c. Access the element at 2nd column and 4th row in a matrix

2. Write a R program to find the maximum and the minimum value of a given vector. Explain the functions with syntax.

3. Write a R program to create a data frame using two given vectors and display the duplicate elements and unique rows of the dat frame. Explain with syntax.

4.. Write a R program to add 3 to each element of the first vector. Print the original and new vector.

5.Check whether the value of the element of a given vector is greater than 10 or not. Return TRUE or FALSE.

6. Write a R program to create an ordered factor from data consisting of the names of months.

IAT / CCE / SEE

E. Scheme of Evaluation

Evaluation :150 MARKS(Pass criteria 50% - 75 marks out of 150)

1. (a).Continuous Internal Evaluation(CIE): 100 Marks

Components	Sum of 3 IATs	CCE	Practical Exam	Total Marks
Max. Marks	30 (Theory-2, Practical – 1)	20 (Theory-2, Practical – 1)	50	100
Theory	20	10		
Practical	10	10		

(b) Practical Exam : 50 Marks

Section	Course with project	Course without project	Total Marks for the Section	Revised Bloom's Taxonomy
Writing Program & Abstract	2 Programs & Project Abstract (10+5)	2 Programs	15	L3
Execution	1 Program & Project Demo (10+10)	2 Programs	20	L4
Viva-Voce	10	10	10	L5
Record/Report	5	5	5	

2. (a)Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L1,L2,L3
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	PO										PSO				
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5
1	*										*				
2		*	*								*				
3															
4			*			*	*	*	*	*		*	*	*	*
5				*			*	*					*	*	

8CSGC6741 : COMPUTER NETWORKS AND SECURITY		
. Course Framework		
Credits: L-T-P-C: 3-0-0-3		**Syllabus Version: 1**
Contact Hours / Week: 3	**Total Contact Hours: 45**	**Level:500**
Prerequisite: (If applicable)	Basic knowledge of computer architecture	

Course Learning Objectives:

CLO1: Demonstration of application layer protocols

CLO2: Discuss transport layer services and understand UDP and TCP protocols

CLO3: Explain routers, IP and Routing Algorithms in network layer

CLO4: Disseminate the Wireless and Mobile Networks covering IEEE 802.11 Standard

CLO5: Illustrate concepts of Multimedia Networking, Security and Network Management

Course Outcomes: On successful completion of the course, Students will be able to,

CO1: Explain principles of application layer protocols (L2)

CO2: Recognize transport layer services and infer UDP and TCP protocols (L2)

CO3: Classify routers, IP and Routing Algorithms in network layer (L3)

CO4: Understand the Wireless and Mobile Networks covering IEEE 802.11 Standard(L4)

CO5: Describe Multimedia Networking and Network Management(L4)

PO: PO1/PO2/PO3/PO6 /PO10 **PSO:**PSO1/PSO2

B. Syllabus

Module I : Application Layer **Hours: 9**

Application Layer: Principles of Network Applications: Network Application Architectures, Processes Communicating, Transport Services Available to Applications, Transport Services Provided by the Internet, Application-Layer Protocols. The Web and HTTP: Overview of HTTP, Non-persistent and Persistent Connections, HTTP Message Format, User-Server Interaction: Cookies, Web Caching, The Conditional GET, File Transfer: FTP Commands & Replies, Electronic Mail in the Internet: SMTP, Comparison with HTTP, Mail Message Format, Mail Access Protocols, DNS; The Internet's Directory Service: Services Provided by DNS, Overview of How DNS Works, DNS Records and Messages, Peer-to-Peer Applications: P2P File Distribution, Distributed Hash Tables, Socket Programming: creating Network Applications: Socket Programming with UDP, Socket Programming with TCP.

Module:2: Transport Layer **Hours: 9**

Transport Layer : Introduction and Transport-Layer Services: Relationship Between Transport and Network Layers, Overview of the Transport Layer in the Internet, Multiplexing and Demultiplexing: Connectionless Transport: UDP,UDP Segment Structure, UDP Checksum, Principles of Reliable Data Transfer: Building a Reliable Data Transfer Protocol, Pipelined Reliable Data Transfer

Protocols, Go-Back-N, Selective repeat, Connection-Oriented Transport TCP: The TCP Connection, TCP Segment Structure, Round- Trip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management, Principles of Congestion Control: The Causes and the Costs of Congestion, Approaches to Congestion Control, Network-assisted congestion-control example, ATM ABR Congestion control, TCP Congestion Control: Fairness.

Module:3: The Network layer **Hours: 9**

The Network layer: What's Inside a Router?: Input Processing, Switching, Output Processing, Where Does Queuing Occur? Routing control plane, IPv6,A Brief foray into IP Security, Routing Algorithms: The Link-State (LS) Routing Algorithm, The Distance-Vector (DV) Routing Algorithm, Hierarchical Routing, Routing in the Internet, Intra-AS Routing in the Internet: RIP, Intra-AS Routing in the Internet: OSPF, Inter/AS Routing: BGP, Broadcast Routing Algorithms and Multicast.

Module:4: Network Security: **Hours: 9**

Network Security: Overview of Network Security: Elements of Network Security , Classification of Network Attacks ,Security Methods ,Symmetric-Key Cryptography :Data Encryption Standard(DES), Advanced Encryption Standard(AES), Public-Key Cryptography: RSA Algorithm, Diffie-Hellman Key-Exchange Protocol, Authentication:Hash Function , Secure Hash Algorithm (SHA) , Digital Signatures , Firewalls and Packet Filtering ,Packet Filtering , Proxy Server .

Module 5 : Multimedia Networking **Hours: 9**

Multimedia Networking: Properties of video, properties of Audio, Types of multimedia Network Applications, Streaming stored video: UDP Streaming, HTTP Streaming, Adaptive streaming and DASH, content distribution Networks

Voice-over-IP : Limitations of the Best-Effort IP Service ,Removing Jitter at the Receiver for Audio ,Recovering from Packet Loss Protocols for Real-Time Conversational Applications , RTP , SIP

C. References

1. Behrouz A Forouzan, Data and Communications and Networking, Fifth Edition, McGraw Hill, Indian Edition
2. Larry L Peterson and Brusce S Davie, Computer Networks, fifth edition, ELSEVIER
3. Andrew S Tanenbaum, Computer Networks, fifth edition, Pearson

Mayank Dave, Computer Networks, Second edition, Cengage Learning

D. Mode of Assessment

IAT / CCE / SEE

E. Scheme of Evaluation

1. **Continuous Internal Evaluation (CIE): 50 Marks**

Components	Average of 2 IATs	CCE	Total Marks
Max. Marks	20	30	50

2. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50 marks).

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L1, L2, L3
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	**PO**										**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**
1	*										*	*			
2		*				*				*	*	*			
3			*			*					*	*			
4			*			*					*	*			
5		*	*								*	*			

8CSGC5751 : DISTRIBUTED COMPUTING		
. Course Framework		
Credits: L-T-P-C: 3-0-0-3		**Syllabus Version: 1**
Contact Hours / Week: 3	**Total Contact Hours: 45**	**Level: 500**
Prerequisite : (If applicable)	Basic knowledge of computer architecture	
Course Learning Objectives:		
CLO1: To introduce students to the fundamental problems, concepts of distributed computing.. **CLO2**: To introduce the design and analysis of distributed computing systems. **CLO3**:To familiarize students with the stages of the distributed system design cycle, including system architecture, data and processes arrangements.		
Course Outcomes: On successful completion of the course, students will be able to,		

CO1: To understand the evolution of distributed computing from its early beginnings as multi-processor and multi-computer systems.(L2)

CO2: To know the design goals of distributed computing systems.(L2)

CO3: To understand some commonly applied architectural styles toward organizing distributed computing systems.(L3)

CO4: To know basic principles of the RPC model and problems with achieving distribution transparency.(L4)

CO5: To discuss the use of publish-subscribe systems for coordination in distributed event matching. (L4

PO: PO1/PO2/PO3/PO5 **PSO**:PSO1/ PSO2/PSO5

B. Syllabus

Module-1: Fundamentals,Message passing Hours: 9

Introduction: Evolution of Distributed Computing Systems, System models, Issues in design of Distributed Systems, Distributed computing environment, web based distributed model, computer networks related to distributed systems and web based protocols.

Message Passing: Inter process Communication, Desirable Features of Good Message-Passing Systems, Issues in IPC by Message, Synchronization, Buffering, Multidatagram Messages, Encoding and Decoding of Message Data, Process Addressing, Failure Handling, Group Communication.

Module-2: Remote Procedure Calls , Distributed Shared Memory Hours:9

Remote Procedure Calls-The RPC Model, Transparency of RPC, Implementing RPC Mechanism, Stub Generation, RPC Messages, Marshaling Arguments and Results, Server Management, Communication Protocols for RPCs, Complicated RPCs, Client-Server Binding, Exception Handling, Security, Some Special Types of RPCs, Lightweight RPC, Optimization for Better Performance.

Module-3: Distributed Shared Memory, Synchronization Hours: 9

Distributed Shared Memory: Design and Implementation issues of DSM, Granularity, Structure of Shared memory Space, Consistency Models, replacement Strategy, Thrashing, Other Approaches to DSM, Advantages of DSM.

Synchronization: Clock Synchronization, Event Ordering, Mutual Exclusion, Election Algorithms.

Module-4: Resource and Process Management Hours: 9

Resource and Process Management: Desirable Features of a good global scheduling algorithm, Task assignment approach, Load Balancing approach, Load Sharing Approach, Process Migration, Threads, Processor allocation, Real time distributed Systems.

Module-5: Distributed File Systems, Naming Hours: 9

Distributed File Systems: Desirable Features of a good Distributed File Systems, File Models, File Accessing Models, File-sharing Semantics, File caching Schemes, File Replication, Fault Tolerance, Design Principles, Sun's network file system, Andrews file system, comparison of NFS and AFS.

Naming : Desirable Features of a Good Naming System, Fundamental Terminologies and Concepts, Systems-Oriented Names, Name caches, Naming & security, DCE directory services.

C. References

1.Distributed OS by Pradeep K. Sinha (PHI)
2. Tanenbaum S.: Distributed Operating Systems, Pearson Education
3. Tanenbaum S. Maarten V.S.: Distributed Systems Principles and Paradigms, (Pearson Education)
4. George Coulouris, Jean Dollimore. Tim Kindberg: Distributed Systems concepts and design.

D. Mode of Assessment

IAT / CCE / SEE

E. Scheme of Evaluation

1. Continuous Internal Evaluation (CIE) : 50 Marks

Components	Average of 2 IAT's	CCE	Total Marks
Max.marks	20	30	50

2. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L1,L2,L3
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	PO										PSO				
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5
1		*									*	*			
2		*	*								*	*			
3	*	*	*								*	*			*
4		*	*		*						*	*			
5	*	*	*								*	*			

8CSGC5281: ADVANCED ALGORITHMS		
A. Course Framework		
Credits: L-T-P-C: 3-0-0-3		**Syllabus Version: 1**
Contact Hours / Week: 03	**Total Contact Hours: 45**	**Level: 600**
Prerequisite: (If applicable)	Prior knowledge of Design and Analysis of Algorithms	
Course Learning Objectives:		
CLO1: To understand various types of algorithms and compute the time complexity. **CLO2:** To apply various string-matching algorithms. **CLO3:** To Apply Probabilistic and Randomized Algorithms.		
Course Outcomes: On successful completion of the course, Students will be able to,		
CO1: Analyze various algorithms using different techniques. (L4) **CO2:** Apply various string-matching algorithms.(L3) **CO3:** Understand various mathematical algorithms and Huffman's algorithms for data compression (L2) **CO4:** Understand various graph algorithms and polynomials. (L2) **CO5:** Apply Probabilistic and Randomized Algorithms. (L3)		
PO: PO1 - PO3/PO9		**PSO: PSO2**
B. Syllabus		
Module1: Analysis of Algorithms		**Hours: 9**
Review of Analysis Techniques: Growth of Functions: Asymptotic notations; Standard notations and common functions; Recurrences and Solution of Recurrence equations- The substitution method, The recurrence – tree method, The master method; Amortized Analysis: Aggregate, Accounting and Potential Methods		
Module 2: String matching algorithms		**Hours: 9**
String-Matching Algorithms: Naïve string Matching; Rabin - Karp algorithm; String matching with finite automata; Knuth-Morris-Pratt algorithm; Boyer – Moore algorithms.		
Module 3: Mathematical and Huffman's algorithm		**Hours: 9**
Elementary notions, GCD, Modular arithmetic, Solving modular linear equations, The Chinese remainder theorem, Powers of an element RSA Cryptosystem, Primality testing, Integer factorization, - Huffman Codes, Polynomials. FFT-Huffman codes: Concepts, construction, Proof correctness of Huffman's algorithm; Representation of polynomials		

Module 4: Graph algorithms and Polynomials	**Hours: 9**
Graph Algorithms: Bellman-Ford Algorithm Single source shortest paths in a DAG, Johnson's Algorithm for sparse graphs, Flow networks and the Ford-Fulkerson Algorithm, Maximum bipartite matching; Polynomials and the FFT: Representation of polynomials; The DFT and FFT; Efficient implementation of FFT.	
Module 5: Probabilistic and Randomized Algorithms	**Hours: 9**
Probabilistic and Randomized Algorithms: Probabilistic algorithms; Randomizing deterministic algorithms, Monte Carlo and Las Vegas algorithms; Probabilistic numeric algorithms	

D. C. References

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, Introduction to Algorithms, Prentice Hall, PHI, 3rd Edition, 2010
2. Kenneth A. Berman, Algorithms, Cengage Learning, 2002
3. Ellis Horowitz, Sartaj Sahni, S.Rajasekharan, Fundamentals of Computer Algorithms, University Press, 2nd Edition, 2007.

E. Mode of Assessment

IAT / CCE / SEE

E. Scheme of Evaluation

1. Continuous Internal Assessment (CIE): 50 Marks

Components	Average of 2 IATs	CCE	Total Marks
Max. Marks	20	30	50

2. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L2, L4
B	6	4	15	60	L1, L2, L3, L4

C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	**PO**										**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**
1	*	*							*			*			
2	*	*	*						*			*			
3	*	*	*						*			*			
4	*	*	*						*			*			
5	*	*	*						*			*			

8CSGC5231 : OBJECT-ORIENTED MODELING AND DESIGN		
A. Course Framework		
Credits: L-T-P-C: 3-0-0-3		**SyllabusVersion:1**
Contact Hours / Week: 3	**Total Contact Hours: 45**	**Level: 600**
Prerequisite : (If applicable)	**Elementary Object-Oriented Concepts**	

Course Learning Objectives:

CLO1: To understand basic Modeling concepts.

CLO2: To Develop Object-Oriented software models representing static and dynamic behavior of a system.

CLO3: To learn the facets of the unified process in analysis and design of a software system.

CLO4: To impart knowledge on design patterns for solving common problems encountered during system development.

Course Outcomes: On successful completion of the course, Students will be able to,

CO1: Develop a Class model for the given application.(L 6)

CO2: Produce State, Sequence, Use case, Activity, Component and Deployment models for real world applications.(L6)

CO3: Describe stages in system development and the process involved in Domain and Application analysis.(L 2)

CO4: Recognize various aspects to be considered during design and implementation phases of software development.(L 2)

CO5: Choose and apply appropriate design pattern for the given problem.(L 3)

PO: PO2/PO3/PO4 **PSO: PSO2/PSO4**

B. Syllabus

Module – 1 : Introduction, Class Modeling **Hours: 9**

What is Object Orientation? What is OO development? OO themes, Evidence for usefulness of OO development, OO modeling history. Modeling as Design Technique: Modeling, abstraction, The three models. Class Modeling: Object and class concepts, Link and associations concepts, Generalization and inheritance, A sample class model, Navigation of class models, Advanced object and class concepts, Association ends, N-array associations, Aggregation, Abstract classes, Multiple inheritance, Metadata, Reification, Constraints, Derived data, Packages.

Module – 2 : State, Interaction, Component and Deployment Modeling **Hours: 9**

State Modeling: Events, States, Transitions and Conditions, State diagrams, State diagram behavior. Advanced State Modeling: Nested state diagrams, Nested states, Signal generalization, Concurrency, A sample state model, Relation of class and state models. **Interaction Modeling:** Use case models, Sequence models, Activity models. Use case relationships, Procedural sequence models, Special constructs for activity models, Component Model, Deployment Model.

Module – 3: Process , System Conception and Analysis **Hours: 9**

Process Overview: Development stages, Development life cycle. System Conception: Devising a system concept, Elaborating a concept, Preparing a problem statement. **Domain Analysis:** Overview of analysis, Domain class model, Domain state model, Domain interaction model, Iterating the analysis. Application Analysis: Application interaction model, Application class model, Application state model, Adding operations.

Module – 4: Design, Implementation Modeling, Legacy Systems **Hours: 9**

System Design: Overview of system design, Estimating performance, Making a reuse plan, Breaking a

system into sub-systems, Identifying concurrency, Allocation of sub-systems, Management of data storage, Handling global resources, Choosing a software control strategy, Handling boundary conditions, Setting the trade-off priorities, Common architectural styles, Architecture of the ATM system as the example. **Class Design:** Overview of class design, Bridging the gap, Realizing use cases, Designing algorithms, Recursing downwards, Refactoring, Design optimization, Reification of behavior, Adjustment of inheritance, Organizing a class design, ATM example. Implementation Modeling: Overview of implementation, Fine-tuning classes, Fine-tuning generalizations, Realizing associations, Testing.

Legacy Systems: Reverse engineering, Building the class models, Building the interaction model, Building the state model, Reverse engineering tips, Wrapping, Maintenance.

Module – 5: Patterns and Design Patterns **Hours: 9**

Patterns: What is a pattern and what makes a pattern? Pattern categories, Relationships between patterns, Pattern description Introduction, Model View Controller, structural decomposition: Whole-Part, **Access control:** Proxy, Communication Patterns: Forwarder-Receiver, Client-Dispatcher-Server, Publisher-Subscriber, Management Patterns: Command processor, View Handler.

C. References

1. Michael Blaha, James Rumbaugh: Object-Oriented Modeling and Design with UML, 2nd Edition, Pearson Education/PHI.

2. Booch G., Rumbaugh J, and Jacobson I.," The Unified Modeling Language User Guide", 2nd Edition, Pearson.

3. Frank Buschmann, Regine Meunier, Hans Rohnert, Peter Sommerlad, Michael Stal,"Pattern-Oriented Software Architecture, A System of Patterns", Volume 1, John Wiley and Sons.

4. Grady Booch et al,"Object-Oriented Analysis and Design with Applications", 3rd Edition, Pearson.

5. Mark Priestley," Practical Object-Oriented Design with UML", 2nd Edition, Tata McGraw-Hill.

6. E. Gamma, R. Helm, R. Johnson, J. Vlissides," Design Patterns-Elements of Reusable Object-Oriented Software", Addison-Wesley.

D. Mode of Assessment

IAT / CCE / SEE
E. Scheme of Evaluation

1. Continuous Internal Evaluation(CIE): 50 Marks

Components	Average of 2 IATs	CCE	Total Marks
Max. Marks	20	30	50

2. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L2,L3,L4
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	PO										PSO				
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5
1		*	*	*										*	
2		*	*	*										*	
3		*										*			
4			*									*			
5		*	*	*										*	

Career Essentials GPSBD1171		
A. Course Framework		
Credits: L-T-P-C: GR		**Syllabus Version: 1.0**
Contact Hours / Week: 2 hours per week	**Total Contact Hours: 15 hours**	**Level: 100**
Prerequisite:(If applicable)	**NIL**	
Course Learning Objectives:		
CL01: To evaluate personal strengths, weaknesses, and interests to develop a resume to secure an internship and a job. CL02: To develop social and emotional intelligence to manage relationships effectively. CL03: To analyse the impact of digital footprints on personal and professional life. CL04: To demonstrate empathy and collaboration in team settings. CL05: To apply effective body language techniques to enhance communication skills.		
Course Outcomes: On successful completion of the course, Students will be able to:		
CO1: Assess personal strengths, weaknesses, and interests to construct a viable career plan. (L5) CO2: Analyse the importance of social and emotional intelligence to facilitate successful relationships. (L4) CO3: Understand the implications of digital footprints on personal and professional life. (L2) CO4: Construct a professional resume and customise it for various job applications / internship applications. (L3) CO5: Build awareness on thoughtfulness, develop honesty, discipline and decisiveness. (L3)		
B. Syllabus		
Module:1: Create a Resume		**Hours: 2 hours**

1. Building the right kind of resume.
2. Understanding the various sections in a resume and their significance.
3. Importance of Keywords, strong Action verbs and optimising them for each job application for an impressive resume.
4. Content versus formatting in a Resume.
5. Prioritising information presented in a Resume, to make the strengths and achievements of the candidate stand out, editing and proofreading a resume mercilessly, to reduce the fluff, and understanding what is 'less is more in a Resume'

Module:2 : Prepare for Internship part A (PFI a) **Hours: 7 hours**

1. Differences between self-awareness, self-esteem, and self-image
2. The 4 facts of Johari window
3. SWOT Analysis, a useful way to self-evaluation
4. Tools and techniques to plan and schedule time
5. Time wasters and Time Thieves
6. Understanding the Time Management Matrix
7. Applying the Ivy Lee Method in Time Management
8. Positive attitude and the subconscious mind
9. Concepts of Conditioning and Triggering in creation of beliefs
10. Erasing negative thought processes and negative beliefs
11. Role of communication in interpersonal skills
12. Positive and negative strokes in communication
13. How being a good listener, appreciating and applauding, can do wonders in relationships
14. Non-verbal communication, and how it can express more than words
15. Understanding the unconscious expression, the feeling of the moment
16. Conveying negative or positive impressions through body language

Module: 3 - Develop Social and Emotional Intelligence **Hours: 2 hours**

1. Introduction to developing social and emotional intelligence and their impact on personal and professional success
2. Concepts of emotional and social intelligence: understanding emotions, emotional hijacking, the emotional brain, roots of empathy, Daniel Goleman's theories
3. How to enhance Emotional Intelligence /quotient.
4. Activities to understand self: how does EQ affect one's performance in the professional world; Know Thyself

Module: 4 - Empathy Elicitation and Collaboration (EEC) **Hours: 2 hours**

1. Stimulating Work
2. Determination
3. Courage
4. Thoughtfulness
5. Strategic planning
6. Inspiration
7. Honesty
8. Expertise
9. Discipline
10. Decisiveness

Module: 5 - Understand your Digital Footprints (UDF)	**Hours: 2 hours**

1. Understanding the importance of the landscape of professional digital social media and digital footprints
2. Introduction to Netiquette: General best practices, Dos and Don'ts.
3. Digital Identity/ Social media presence and its role in Recruitment and employment.
4. How to create an impressive LinkedIn and Facebook profile for professional networking purposes

C. References

1. Elizabeth Diamond. (2010). *7 Mindsets to Master Self Awareness*. Authorhouse.
2. Brian Tracy. (2001). *Eat That Frog.* Berret-Koehler.
3. Heidi Grant Halvorson. (2011). *9 things successful people do differently.* Harvard Business Review Press.
4. Norman Vincent Peale. (1952). *The Power of Positive Thinking.* Prentice Hall.
5. Stephen R Covey. (1989). *The 7 Habits of Highly Effective People.* Free Press.
6. Dale Carnegie. (1936). *How to Win Friends & Influence People.* Simon & Schuster.
7. Allan & Barbara Pease. (2004). *The Definitive Book of Body Language.* Harper.
8. Daniel Goleman. (2009). Emotional Intelligence: Why it can matter more than IQ. HarperCollins
9. Travis Bradbury & Jean Greaves (2007). Emotional Intelligence 2.0. TalentSmart, CA USA
10. Adele B. Lynn & Janelle R. Lynn (2009). The Emotional Intelligence Activity Kit. Amacom, USA
11. Bob Bellhouse, Andrew Fuller, Glenda Johnson & Neil Taylor (2005). Managing The Difficult Emotions. Paul Chapman Publishing, UK
12. Lisa McGrimmon. (2015). The Resume Writing Guide. Create Space Publishing

D. Mode of Assessment : Continuous Internal Evaluation (CIE)

E. Scheme of Evaluation
Components: CIE
Max Marks: 50

New Soft Skills	CIE (2 sets of MCQ's for 25 each)		Remarks
Evaluation	CIE-1	CIE-2	Grand Total (A+B)
Column Identifier >	A	B	C
Max. Marks	25	25	50

GPSBA1021 - Preparing for Aptitude Tests [UG-1/2]		
A. Course Framework		
Credits: L-T-P-C: NA – Graduate Requirement (GR)		**Syllabus Version: 1.0**
Contact Hours / Week: 2	**Total Contact Hours: 30**	**Level: 100**
Prerequisite: (If applicable)	**NA**	

Course Learning Objectives:

COL1: To build competence in aptitude skills (Quantitative, Logical Reasoning, and Verbal Ability).
COL2: To improve the students' aptitude skills to ace such tests in the future.
COL3: To develop problem-solving abilities essential for employment.
COL4: To support students' transition from Campus to the Corporate environment.

Course Outcomes: On successful completion of the course, Students will be able to,

CO1: Remember the calculation techniques for quick calculations and manipulation of numbers. [Level-1]

CO2: Apply the concepts of percentages, exponents, ratios, and proportions for computing simple, compound interests and calculating class /set relationships. [Level-3]

CO3: Understand how to analyze the sufficiency of data and interpret its specific components by solving problems. [Level-2]

CO4: Analyze the concepts of Venn diagrams to solve puzzles using set theory. [Level-4]

B. Syllabus

Module:1: Percentage and its Applications, Ratio, Proportion, Variation & Partnership Hours: 5

1) Calculation of percentage and fraction equivalence
2) Percentage change or percentage increment and decrement
3) Problems based on Profit, Loss and Discount
4) Problems based on Simple Interest and Compound Interest
5) Understanding ratios
6) Problems based on compounding of ratios.
7) Comparison of ratios
8) Applications based on equal ratios.
9) Concepts & problems involving direct, inverse, and joint variation.
10) Problems based on the distribution of profits in a partnership.

Module:2: Logical Reasoning- Seating Arrangements, Data Interpretations Hours: 5

1) Understanding the difference between Linear Arrangement and Circular Arrangement
2) Problems based on Linear Arrangement, Circular Arrangement, and Square Arrangement
3) Types of representation of data
4) Interpreting various graphs like line, pie, bar, table, etc.

Module:3: Data Sufficiency, Venn Diagrams, Cube **Hours: 5**

1) Concept of data sufficiency
2) Quant and reasoning-based sufficiency problems
3) Visual representation of Venn-Diagram for 2 variables, 3 variables, and 4 variables
4) Learn to name regions of Venn-Diagram.
5) Rules associated with filling the regions of a Venn diagram.
6) Formulae associated with set theory and Venn-Diagram.
7) Puzzles based on Venn diagrams.
8) The concept of breaking cubes into identical pieces
9) Concept of building a cube from identical pieces.
10) Segregating the cut pieces of a cube based on faces painted.
11) Puzzles based on cubes

Module:4: Tenses and Articles **Hours: 5**

1) Understanding the role of tenses in English grammar
2) 16 tenses in the English language
3) Understanding the formula of all tenses
4) Awareness of rules related to Articles.

Module:5: Vocabulary, Synonyms and Antonyms, Verbal Analogies **Hours: 10**

1) Importance of having a strong vocabulary.
2) Understanding the meaning of roots, to derive the meaning of words.
3) Knowing the simple ways to improve the vocabulary.
4) How to learn synonyms and antonyms easily.
5) Using the thesaurus for learning
6) Making lists of words and relating them to remember
7) Verbal and non-verbal analogies
8) Discovering the logical connection between words

C. References

1. Guha, A. (2016). *Quantitative Aptitude for Competitive Examination*. Tata McGraw-Hill.
2. Gupta, A.K. (2016). *Logical and Analytical Reasoning*. Ramesh Publishing House.
3. Aggarwal, R.S. (2017). *Quantitative Aptitude for Competitive Examination*. S-Chand Publishing.

D. Mode of Assessment

CIE: IAT/CCE

E. Scheme of Evaluation

School of Science and Computer Studies

Master of Science IT in Data Science

GR Courses (PAT / PATL)	IAT	CCE						CIE	SEE	Total
Evaluation	IAT	CCE-1	CCE-2	CCE-3	CCE-4	CCE-5	Total CCE (B to F)	CIE (IAT + CCE) (A + G)	SEE	Grand Total (H + I)
Column Identifier >	A	B	C	D	E	F	G	H	I	J
Max. Marks	NA	10	10	10	10	10	50	50	NA	**50**

SECOND SEMESTER

8CSDS5231: Big Data Analytics using Hadoop		
. Course Framework		
Credits: L-T-P-C: 3-0-2-5		**Syllabus Version: 1**
Contact Hours / Week: 7	**Total Contact Hours: 105**	**Level: 600**
Prerequisite : (If applicable)	Basic knowledge of Database Management Systems	
Course Learning Objectives:		
CLO1: To understand the big data platform and its use cases **CLO2:** To understand the overview of Apache Hadoop **CLO3:** To learn about HDFS concepts and interfacing with HDFS **CLO4:** To understand map reduce jobs **CLO5:** To learn about Hadoop streaming **CLO6**: To learn about Hive and Pig		
Course Outcomes: On successful completion of the course, Students will be able to,		
CO1: Apply the Big Data concepts in real time scenario (L3) **CO2**: Understand the architecture of Hadoop with practical (L3) **CO3**: Apply map reduce concept to implement in cloud (L4) **CO4**: Develop Big Data Solutions using Hadoop ecosystem (L4)		
PO: PO1-PO4/PO7/PO9	**PSO**: PSO1/PSO3/PSO4	
Syllabus		
Module 1: Introduction to Big Data and Hadoop		**Hours: 9**
Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications, Algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce. Apache Hadoop– Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce - Data Serialization, Problems with traditional large-scale systems-Requirements for a new approach-Hadoop – Scaling-Distributed Framework-Hadoop v/s RDBMS-Brief history of Hadoop.		
Module: 2: Configurations of Hadoop		**Hours: 9**
Hadoop Processes (NN, SNN, JT, DN, TT)-Temporary directory – UI-Common errors when running Hadoop cluster, solutions. Setting up Hadoop on a local Ubuntu host: Prerequisites, downloading Hadoop, setting up SSH, configuring the pseudo-distributed mode, HDFS directory, NameNode, Examples of MapReduce, Using Elastic MapReduce, Comparison of local versus EMR Hadoop. Understanding MapReduce:Key/value pairs,TheHadoop Java API for MapReduce, Writing MapReduce programs, Hadoop-specific data types, Input/output. Developing MapReduce Programs: Using languages other than Java with Hadoop, Analysing a large dataset.		
Module 3: Advanced Map Reduce Techniques		**Hours: 9**
Simple, advanced, and in-between Joins, Graph algorithms, using language-independent data structures. Hadoop configuration properties - Setting up a cluster, Cluster access control, managing the NameNode, Managing HDFS, MapReduce management, Scaling.		
Module 4: Hadoop Streaming		**Hours: 9**
Hadoop Streaming - Streaming Command Options - Specifying a Java Class as the Mapper/Reducer - Packaging Files With Job Submissions - Specifying Other Plug-ins for Jobs.		

Module:5: HIVE & PIG **Hours: 9**

Hadoop Streaming - Streaming Command Options - Specifying a Java Class as the Mapper/Reducer - Packaging Files With Job Submissions - Specifying Other Plug-ins for Jobs.

PART A

1. Word count application in Hadoop.
2. Sorting the data using MapReduce.
3. Finding max and min value in Hadoop.
4. Implementation of decision tree algorithms using MapReduce.
5. Implementation of K-means Clustering using MapReduce.
6. Generation of Frequent Itemset using MapReduce.
7. Count the number of missing and invalid values through joining two large given datasets.
8. Using hadoop's map-reduce, Evaluating Number of Products Sold in Each Country in the online shopping portal. Dataset is given
9. Analyze the sentiment for product reviews, this work proposes a MapReduce technique provided by Apache Hadoop.

Trend Analysis based on Access Pattern over Web Logs using Hadoop.

PART B

Mini Project

Risk Analysis/ Fraud Analysis on Big Data (Banking, Healthcare, Media etc..)

References

1. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, Professional Hadoop Solutions, Wiley, 2015.
2. Tom White, Hadoop: The Definitive Guide, O'Reilly Media Inc., 015.
3. Garry Turkington, Hadoop Beginner's Guide, Packt Publishing, 2013.
4. Pethuru Raj, Anupama Raman, DhivyaNagaraj and Siddhartha Duggirala, HighPerformance Big-Data Analytics: Computing Systems and Approaches, Springer, 2015.
5. Jonathan R. Owens, Jon Lentz and Brian Femiano, Hadoop Real-World Solutions Cookbook, Packt Publishing, 2013.
6. Tom White, HADOOP: The definitive Guide, O Reilly, 2012

Mode of Assessment

IAT / CCE / SEE

Scheme of Evaluation

1. (a).Continuous Internal Evaluation(CIE): 100 Marks

Components	Sum of 3 IATs	CCE	Practical Exam	Total Marks
Max. Marks	30 (Theory-2, Practical – 1)	20 (Theory-2, Practical – 1)	50	100
Theory	20	10		
Practical	10	10		

(b) Practical Exam : 50 Marks

Section	Course with project	Course without project	Total Marks for the Section	Revised Bloom's Taxonomy
Writing Program & Abstract	2 Programs & Project Abstract (10+5)	2 Programs	15	L3
Execution	1 Program & Project Demo (10+10)	2 Programs	20	L4
Viva-Voce	10	10	10	L5
Record/Report	5	5	5	

2. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy

A	7	5	5	25	L3
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	PO										PSO				
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5
1	*	*							*		*		*		
2	*	*							*				*		
3			*	*							*		*		
4		*	*	*			*				*		*	*	

8CSAI6131:ARTIFICIAL INTELLIGENCE AND LAB		
A. Course Framework		
Credits: L-T-P-C: 3-0-2-5		**Syllabus Version: 1**
Contact Hours / Week: 7	**Total Contact Hours:105**	**Level: 600**
Prerequisite : (If applicable)	Basic knowledge of Statistics, Linear Algebra, Probability, Python Programming Language, Data Modeling	

Course Learning Objectives:

CLO1: To introduce the basic concepts of Artificial Intelligence, with illustrations of current state of the art research and applications.

CLO2: To recognize the characteristics of AI that make it useful to real-world problems

CLO3: To identify the type of an AI problem(search inference, decision making under uncertainty, game theory,etc.)

CLO4: To introduce expert systems that can be built for solving real life problems

Course Outcomes: On successful completion of the course, Students will be able to,

CO1: Gain knowledge on task domains and problem spaces (L2,L3)

CO2: Analyze problems and solve using searching techniques (L4, L6)

CO3: Build problem solving agents and evaluate performance (L5,L6)

CO4: Gain knowledge on various learning systems and apply best suited one to real world problems (L3,L4,L5)

CO5: Gain knowledge on expert systems and design solutions for real life problems (L2,L6)

PO: PO1/PO2 **PSO:**PSO1/PSO2

B. Syllabus

Module 1: Introduction to AI **Hours: 9**

Introduction to AI : Definition, History of AI, AI Problems-Task Domains of Artificial Intelligence; The Underlying Assumption - Physical Symbol System Hypothesis; AI technique - Knowledge properties, Knowledge Representation Problems .**Problem Spaces :** Steps in building a System; Production Systems; Control Strategies-Requirements of a good control strategy; Problem Characteristics; Production System Characteristics-Categories of Production Systems.

Module 2: Problem Solving by Search **Hours: 9**

Searching:Uninformed Search Strategies- Breadth-first search, Depth-first search; Informed Search Strategies-Greedy best-first, A* search,Hill-Climbing Search,Adversarial Search; Heuristic search techniques: Generate-and-test, Hill Climbing-Simple Hill Climbing, Best First Search-OR Graphs

Game Playing: Adversarial search, Games, Minimax algorithm, Optimal decisions in multiplayer games, Alpha-Beta pruning, Evaluation functions, cutting of search. Constraint Satisfaction Problems – Defining Constraint Satisfaction Problems-Example problem-Map coloring.

Module 3: Knowledge Representation **Hours: 9**

Intelligent Agents: Agents and Environments;Concept of Rationality, Nature of environments, Structure of Agents, Types of Agents, Problem solving Agents, Problem formulation, A Rational Agent – Performance measures,PEAS; Examples of Agent Types; First Order Logic, Propositional Logic-Resolution, Forward and Backward Chaining

Knowledge Representation: Introduction, Definition, Importance, Representation and Mappings mappings between facts and representations, Representation of Facts; Approaches to Knowledge Representation-Properties, Types of Knowledge; Issues in Knowledge Representation-Important Attributes, Relationship among Attributes.

Module 4: Learning systems **Hours: 9**

Learning systems: Forms of learning - Rote learning, Inductive learning, Explanation based learning - extracting general rules from examples, learning using relevant information, learning by example, Supervised learning, Unsupervised learning, Reinforcement learning - Learning decision trees - Representation, Expressiveness, Examples, Ensemble learning , Knowledge in learning – Logical formulation of learning – Least commitment search, Explanation based learning – Extracting general rules from examples, Learning using relevant information

Module:5: Expert Systems **Hours:9**

Expert systems: Introduction, Characteristics, Components, Knowledge acquisition, inter knowledge,Heuristics – Knowledge representation – production based system, frame based system. Inference- backward chaining, forward chaining, rule value approach, Fuzzy reasoning – certainty factors Type of expert systems, Stages in the development

of an Expert System , Expert System Tools and Languages, Applications of Expert Systems, Typical examples of expert systems.

Section A

1. Write a program to implement DFS
2. Write a program to implement BFS
3. Write a Program to find the solution for travelling salesman Problem
4. Write a program to implement Simulated Annealing Algorithm
5. Write a program to find the solution for wampus world problem
6. Write a program to implement 8 puzzle problem
7. Write a program to implement A* Algorithm
8. Write a program to implement Hill Climbing Algorithm.
9. Write a program to implement alpha-beta pruning.
10. Write a program to implement 4-Queen's problem.

Section B (Mini Project)

1. Build a chatbot
2. Build a game playing robot

C. References

1. Elaine Rich, Kevin Knight, Shivashankar B Nair, "Artificial Intelligence", 3rd Edition, Tata Mc Graw Hill, 2013
2. Stuart Russel,Peter Norvig,"Artificial Intelligence – A Modern Approach". Second Edition,PHI/ Pearson Education.
3. "Introduction to Artificial Intelligence and Expert Systems",Patterson and Dan W, PHI.
4. "Expert Systems: Principles and Programming", Joseph C. Giarratano, Gary D. Riley,Fourth Edn.
5. Jean-Louis Ermine," Expert Systems: Theory and Practice", Prentice Hall of India, 1995
6. "Artificial Intelligence – A Modern Approach". Second Edition, Stuart Russel, Peter Norvig, PHI/ Pearson Education.

D. Mode of Assessment
IAT / CCE /SEE
E. Scheme of Evaluation

Evaluation :150(Pass criteria 50% - 75 marks out of 150)

1(a) Continuous Internal Evaluation(CIE): 100 Marks

Components	Sum of 3 IATs	CCE	Practical Exam	Total Marks
Max. Marks	30 (Theory-2, Practical – 1)	20 (Theory-2, Practical – 1)	50	100
Theory	20	10		
Practical	10	10		

(b). Practical Exam: 50 Marks

Section	Course with project	Course without project	Total Marks for the Section	Revised Bloom's Taxonomy
Writing Program & Abstract	2 Programs & Project Abstract (10+5)	2 Programs	15	L3
Execution	1 Program & Project Demo (10+10)	2 Programs	20	L4
Viva-Voce	10	10	10	L5
Record/Report	5	5	5	

2. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L2, L3,L4
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	PO										PSO				
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	
1	*	*									*				
2	*	*									*	*			
3	*	*													
4	*	*										*			
5	*	*									*	*			

8CSAI6141: INTERNET OF THINGS AND LAB		
A. Course Framework		
Credits: L-T-P-C: 3-0-2-5		**Syllabus Version: 1**
Contact Hours / Week: 7	**Total Contact Hours: 105**	**Level: 600**
Prerequisite : (If applicable)	Basic knowledge Python Programming	
Course Learning Objectives:		
CLO1: To educate our students in IoT technologies, data analytics and security aspects of IoT.		
Course Outcomes: On successful completion of the course, Students will be able to,		
CO1: Explain about IoT and its network architecture.(L2) **CO2:** Explain IoT things and various access technologies.(L2) **CO3**: Analyze and optimize the IP for IoT.(L4) **CO4**: Apply the data analytics tools for analyzing the IoT data. (L3) **CO5**: Explain and analyze the risk factors of IoT. (L4)		
PO:PO1-PO4/PO6-PO10	**PSO:** PSO1-PSO4	
B. Syllabus		
Module 1: Introduction to IoT		**Hours: 9**
Introduction to IoT: Genesis, Impact, challenges; IoT network Architecture and Design, Drivers behind new network architecture, comparing IoT architectures, simplified IoT architecture, core IoT functional stack, IoT data management and compute stack		
Module 2: Engineering IoT Networks		**Hours: 9**
Smart objects: the “Things” in IoT: Sensors, actuators, and smart objects, sensor networks; Connecting smart objects: ranges, frequency bands, power consumption, topology, constrained devices, constrained-node network; IoT access technologies: IEEE 802.15.4, IEEE 802.15.4g and 802.15.4e, IEEE 1901.2a, IEEE 802.11ah, LoRaWAN and NB-IoT and other LTE variations.		
Module 3: IP as the IoT Network Layer and Application protocols for IoT		**Hours: 9**

IP as the IoT Network Layer : The Business Case for IP, Need for optimization, optimizing IP for IoT: From 6LoWPAN to 6Lo, Header Compression, Fragmentation, Mesh Addressing, 6Lo Working Group, 6TiSCH, Static scheduling, RPL, Metrics, ACE, DICE, Profiles and compliances.

Application protocols for IoT: The transport layer, IoT Application Transport Methods: Application layer protocol not present, Supervisory control and data acquisition (SCADA), Generic web-based protocols, IoT application layer protocols.

Module 4: Data Analytics for IoT **Hours: 9**

An Introduction to Data Analytics for IoT, IoT Data Analytics Overview, Machine Learning,

Big Data Analytics Tools and Technology: Massively Parallel Processing Databases- NoSQL Databases, Hadoop, YARN, The Hadoop Ecosystem, Apache Kafka, Apache Spark, Apache Storm and Apache Flink, Lambda Architecture. Edge Streaming Analytics, Network Analytics.

Module 5: Securing IoT **Hours: 9**

A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment.`

PART A

1. Understanding the Gateway: Arduino, Raspberry Pi model
2. Integration of Sensors with Raspberry Pi / Arduino
3. Integration of Sensors/Actuators using breadboard with Raspberry Pi model
4. Raspbian OS installation and powering up the Raspberry Pi board
5. Powering up the Arduino and transferring the program from Arduino IDE to the Arduino board
6. Scanning IP address of Pi and accessing Raspberry Pi from SSH and VNC Viewer
7. Python program to send Email with MIME Text
8. Experiment to sense temperature and humidity
9. Experiment to blink LEDs using python program
10. Experiment to blink LEDs using Arduino using C++ program
11. Experiment to measure distance using ultrasonic sensor
12. Experiment to open and close a parking gate
13. Experiment to control electronic devices from mobile
14. Experiment to measure heart beats using pulse sensor
15. Experiment to measure moisture and switching on the water pump

PART B (Mini Project)

An IoT project should be designed in a group of two/three students.

Sample project titles:

1. Smart traffic system
   a. Data analysis using IoT cloud.
   b. Automatically operating traffic
   c. Clearing traffic when ambulance detected
   d. Capturing data on traffic rule violation
2. Smart camera
3. Smart parking system

C. References

1. IoT fundamentals – By *David Hanes, Gonzalo, Patrick, Rob B, Jerome*- Cisco Press
2. IoT Experiments: Learn IoT, the Programmer's way (English Edition) Paperback – October 18, 2019, by Yashavant Kanetkar (Author), Shrirang Korde
3. Internet of Things and Data Analytics Handbook Hardcover – by Hwaiyu Geng
4. https://www.javatpoint.com/iot-tutorial
5. https://circuitdigest.com/internet-of-things-iot-projects.

D. Mode of Assessment

IAT / CCE / SEE

E. Scheme of Evaluation

Evaluation :150 marks(Pass criteria 50% - 75 marks out of 150)

a. Continuous Internal Evaluation (CIE): 100 Marks

Components	Sum of 3 IATs	CCE	Practical Exam	Total Marks
Max. Marks	30	20	50	100

	(Theory-2, Practical– 1)	(Theory-2, Practical – 1)		
Theory	20	10		
Practical	10	10		

2. Semester End Examination (SEE) Scheme (Practical): 50 Marks

Section	Course with project	Course without project	Total Marks for theSection	Revised Bloom's Taxonomy
Writing Program & Abstract	2 Programs & Project Abstract (10+5)	2 Programs	15	L3
Execution	1 Program & Project Demo (10+10)	2 Programs	20	L4
Viva-Voce	10	10	10	L5
Record/Report	5	5	5	

3. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L2, L3,L4
B	6	4	15	60	L1, L2, L3, L4

C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	**PO**										**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**
1	*														
2		*										*			
3				*			*					*			
4			*				*	*	*	*	*	*	*	*	
5						*	*	*		*			*		

8CSGC6241: SOFTWARE PROJECT MANAGEMENT		
A. Course Framework		
Credits: L-T-P-C: 3-0-0-3		**Syllabus Version: 1**
Contact Hours / Week: 4	**Total Contact Hours: 45**	**Level: 600**
Prerequisite : (If applicable)	**-**	

Course Learning Objectives:

CLO1: To understand the Software Project management activities, planning and evaluation techniques.

CLO2: To estimate and manage budgets, project scheduling,monitoring and controlling projects

CLO3: To learn about the activity planning and risk management principles and configuration management

CLO4: To understand organizational behavior, staff acquisition, Decision making and Leadership in software projects

CLO5: To be able to measure and evaluate project performance and Project Report Writing

Course Outcomes: On successful completion of the course, Students will be able to,

CO1: Identify and plan project management activities and develop Statement of Work. (L3,L4)

CO2: Estimate software costs, schedule projects and evaluate project metrics (L 3,L 4,L 5)

CO3: Identify risks, manage software configurations, use software tools for project management(L3,L4)

CO4: Analyze the staff requirements of project, motivation, safety, professional and ethical concerns(L3,L4) **CO5**: Analyze project performance, identify concerns, evaluate and control the projects(L 4,L 5)

PO: PO1-PO4/PO7/PO9 **PSO**: PSO1/PSO3/PSO4

C. Syllabus

Module 1:Overview of Project Management and Planning **Hours: 9**

Overview: Project Life Cycle, Introduction to Project Management, Factors Influencing Project Management, Role of Project Manager, Project Management Activities, Stakeholders of Project; Project Development Phases, Project Charter; Statement of Work (SoW).

Project Planning: Need, Project Planning process, Tasks in Project Planning; Steps in Project planning- Select Project , Identify Project Scope and Objectives , Identify Project Infrastructure Analyze Project Characteristics , Identify Project Products and Activities, Estimate Effort for Each Activity, Identify Activity Risks, Allocate Resources, Review/Publicize Plan, Execute Plan/Lower Levels of Planning; Work Breakdown Structures (WBS); Planning Methods

Module: 2: Software Project Management **Hours: 9**

Estimation and Budgeting of Projects: Software Cost Estimation; LOC based estimation, FP based estimation, COCOMO Model; Budgeting;

Project Scheduling: Scheduling Techniques – Program Evaluation and Review Technique (PERT), Gantt Chart, Critical Path Method (CPM), Automated Tools

Project Monitoring and Controlling: Project Status Reporting; Project Metrics- Size oriented metrics and Function oriented metrics for software measurement; Earned Value Analysis (EVA); Project Communication Plan & Techniques; Steps for Process Improvement

Risk Management: Risk Management Activities, Effective Risk Management, Risk Categories, Potential Risk Treatments, Risk Components and Drivers, Risk Prioritization.

Module 3: Project Management Framework **Hours: 9**

Project Management Framework: Software Tools for Project Management, Model based software architectures, Process workflow, Project Quality Management.

Configuration Management: Software Configuration Management (SCM) – Baselines, Software Configuration Items (SCI); SCM Process; Identification of Objects in the Software Configuration; Version Control; Change Control; Configuration Audit; Status Reporting; Goals of SCM.

Module 4: Staffing in Software Projects **Hours: 9**

Issues in Project Staff Acquisition and Team formation and Development, managing people, Organizational behavior, Best methods of staff selection, Motivation, The Oldham – Hackman job characteristic model, Stress, Health and Safety, Ethical and Professional concerns, working in teams, Decision making, Organizational structures, Dispersed and Virtual teams, Communications genres, Communication plans, Leadership.

Module:5: Project Evaluation and Documentation **Hours: 9**

Project Performance Measurement and Evaluation: Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Controlling the Projects

Writing Reports: Synopsis Format, Abstract, Literature survey Report writing; Case Studies in Project Management.

D. References

1. Walker Royce, "Software Project Management - A Unified", Pearson Education, 1st Edition,2005.
2. Bob Hughes, Mike Cotterell, Rajib Mall, "Software Project Management", Tata McGraw-Hill, 6th Edition, 2018.
3. Kathy Schwalbe, 'Information Technology Project management', Thomson Publication,3rd Edition, 2003.
4. Robert K. Wysocki, " Effective Software Project Management", Wiley Publication,1st Edition, 2011.
5. S.A. Kelkar, "Software Project Management, A Concise Study', Prentice-Hall India, 3rd Edition, 2012.
6. Pankaj Jalote, "Software Project Management in Practice", Pearson Education, 1st Edition, 2015.
7. Gopala swamy Ramesh, "Managing Global Software Projects", McGraw Hill Education (India), Fourteenth Reprint, 2017.
8. Shailesh Mehta, "Project Management and Tools & Technologies – An overview" Shroff Publishers, 1st Edition, 2017.

E. Mode of Assessment

IAT / CCE / SEE

F. Scheme of Evaluation

1. Continuous Internal Evaluation(CIE): 50 Marks

Components	Average of 2 IATs	CCE	Total Marks
Max. Marks	20	30	50

0. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L3
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	PO										PSO				
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5
1	*	*							*		*		*		
2	*	*							*				*		
3			*	*							*		*		
4		*	*	*			*				*		*	*	
5			*	*									*		

8CSGC6431 : OPTIMIZATION TECHNIQUES

. Course Framework

Credits: L-T-P-C: 3-0-0-3		**Syllabus Version: 1**
Contact Hours / Week: 3	**Total Contact Hours: 45**	**Level:600**
Prerequisite: (If applicable)	Basic Algebra	

Course Learning Objectives:

CLO1: Operation research models using optimization techniques based upon the fundamentals of engineering mathematics (minimization and Maximization of objective function).

CLO2 :The problem formulation by using linear, dynamic programming, game theory and queuing models.

CLO3: The stochastic models for discrete and continuous variables to control inventory and simulation of manufacturing models for the production decision making.

CLO4: Formulation of mathematical models for quantitative analysis of managerial problems in industry

Course Outcomes: On successful completion of the course, Students will be able to,

CO 1 Recall the theoretical foundations of various issues related to linear programming modeling to formulate real-world problems as a L P model Explain the theoretical workings of the graphical, simplex and analytical methods for making effective decisions on variables so as to optimize the objective function. (L3)

CO 2 Identify appropriate optimization methods to solve complex problems involved in various industries.(L4)

CO 3 Find the appropriate algorithm for allocation of resources to optimize the process of assignment. Explain the theoretical workings of sequencing techniques for effective scheduling of jobs on machines. (L4)

CO 4 Identifies appropriate equipment replacement techniques to be adopted to minimize maintenance cost by eliminating equipment break-down. Apply the knowledge of game theory concepts to articulate real-world competitive situations to identify strategic decisions to counter the consequences. (L3)

CO 5 Demonstrate the various selective inventory control models to analyze and optimize inventory systems. Explain the theoretical workings of dynamic programming method to find the shortest path for a given network. (L4)

B. Syllabus

Module I : Introduction of operation research. 9 Hours
LP Formulations, Graphical method for solving LP's with 2 variables, Simplex method, Duality theory in linear programming and applications, Integer linear programming, dual simplex method,
Module 2 : Dynamic Programming, Sequence Models 9 Hours
Module:2: Transportation problem, Assignment problem. Dynamic Programming : Basic Concepts, Bellman's optimality principles, Dynamics programming approach in decision making problems, optimal subdivision problem. Sequencing Models: Sequencing problem, Johnson's Algorithm for processing n jobs through 2 machines, Algorithm for processing n jobs through 3 or more machines, Processing 2 jobs through n machines.
Module 3: Project Management 9 Hours
Module:3: Project Management : PERT and CPM : Project management origin and use of PERT, origin and use of CPM, Applications of PERT and CPM, Project Network, Diagram representation, Critical path calculation by network analysis and critical path method (CPM), Determination of floats, Construction of time chart and resource labeling, Project cost curve and crashing in project management, Project Evaluation and review Technique (PERT).
Module 4: Queuing Models 9 Hours
Module:4: Queuing Models : Essential features of queuing systems, operating characteristics of queuing system, probability distribution in queuing systems, classification of queuing models, solution of queuing M/M/1 : /FCFS,M/M/1 : N/FCFS, M/M/S : /FCFS, M/M/S : N/FCFS
Module 5 : Inventory Models 9 Hours
Module 5 : Inventory Models : Introduction to the inventory problem, Deterministic Models, The classical EOQ (Economic Order Quantity) model, Inventory models with deterministic demands(no shortage & shortage allowed), Inventory models with probabilistic demand, multi item deterministic models.
C. References
1.Gillet B.E. : Introduction to Operation Research, Computer Oriented Algorithmic approach - Tata McGraw Hill Publishing Co. Ltd. New Delhi. 2. P.K. Gupta & D.S. Hira, "Operations Research", S.Chand & Co. 3. J.K. Sharma, "Operations Research: Theory and Applications", Mac Millan. 4. S.D. Sharma, "Operations Research", Kedar Nath Ram Nath, Meerut (UP).

5. S.S. Rao "Optimization Theory and Application", Wesley Eastern.
6. Tata Hamdy, A "Operations Research - An Introduction", Fifth Edition, Prentice Hall of India Pvt. Ltd., New Delhi.
7. Taha H.A. "Operations Research an Introduction" McMillan Publication

D. Mode of Assessment

IAT / CCE / SEE

E. Scheme of Evaluation

1. Continuous Internal Evaluation (CIE): 50 Marks

Components	Average of 2 IATs	CCE	Total Marks
Max. Marks	20	30	50

Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50 marks).

1. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L3
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping		
CO	**PO**	**PSO**

Master of Science IT in Data Science

	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5
1	*												*		
2		*				*				*					
3			*			*					*				
4				*		*						*			
5			*		*	*									

8CSDS6291: MultiVariate Data Analysis		
A. Course Framework		
Credits: L-T-P-C: 3-0-0-3		**Syllabus Version: 1**
Contact Hours / Week: 3	**Total Contact Hours: 45**	**Level:600**
Prerequisite: (If applicable)	Basic Algebra	

Course Learning Objectives:

CLO1: Inculcate the knowledge on various multivariate statistical techniques and its applications

CLO2: know the usage of dependence and interdependence multivariate methods

CLO3: know the statistics associated with principal component and factor analysis

CLO5: impart the regression and classification techniques

CLO1: learn the various clustering methods

Course Outcomes: On successful completion of the course, Students will be able to,

CO1 : Distinguish between dependence and interdependence techniques L2

CO2: Fit the various regression models and predict the results L3

CO3: Perform the dimension reduction techniques and interpret the results L4

CO4: Discriminate and classify the given objects by using target variable L4

CO5: Form the groups by using suitable clustering techniques L4

C. Syllabus

Module I :Introduction to Multivariate Analysis **9 Hours**

Meaning of Multivariate Analysis – Multivariate Analysis in Statistical Terms – Basic concepts: Variate, Measurement Scales, Measurement Error, Multivariate Measurement, Statistical Significance and Statistical Power. Classification of Multivariate Techniques: Dependence and Independence Techniques – Applications of Multivariate Techniques.

Module:2: Multiple Regression Analysis	**9 Hours**
Concept of Simple and Multiple Regressions – Illustrations. Prediction using Single and Several Independent Variables – Decision Process in Multiple Regression Analysis: Objectives, Research Design, Assumptions, Estimation of Regression Model – Assessing Model Fit – Interpretation of Regression Variate using Regression Coefficients and Assessing Multicollinearity.	
Module:3: Factor Analysis	**9 Hours**
Notion of Principal Components and Factors – Concept of Data Summarization and Data Reduction - Introduction to Principal Component Analysis and Factor Analysis – Illustrations. Decision Process in Factor Analysis: Objectives, Design, Assumptions, Deriving Factors, Interpretation of Factors, Validation of Factors – Illustrations.	
Module:4: Discriminant Analysis	**9 Hours**
Concept of Discriminant Function – Meaning of Discriminant Analysis – Decision Process in Discriminant Analysis: Objectives, Research Design, Assumptions, Estimation of Discriminant Model, Assessing Model Fit, Interpretation.	
Module 5 : Cluster Analysis	**9 Hours**
Meaning and Conceptual Development of Cluster Analysis – Decision Process in Cluster Analysis: Objectives, Research Design, Assumptions, Deriving Clusters, Interpretation of Clusters, 23 Validation and Profiling of Clusters – Illustrations – Basic Notion of Hierarchical and Nonhierarchical Clusters	

D. References

1.Gillet B.E. : Introduction to Operation Research, Computer Oriented Algorithmic approach - Tata McGraw Hill Publishing Co. Ltd. New Delhi.
2. P.K. Gupta & D.S. Hira, “Operations Research”, S.Chand & Co.
3. J.K. Sharma, “Operations Research: Theory and Applications”, Mac Millan.
4. S.D. Sharma, “Operations Research”, Kedar Nath Ram Nath, Meerut (UP).
5. S.S. Rao “Optimization Theory and Application”, Wesley Eastern.
6. Tata Hamdy, A “Operations Research - An Introduction”, Fifth Edition, Prentice Hall of India Pvt. Ltd., New Delhi.
7. Taha H.A. “Operations Research an Introduction” McMillan Publication

E. Mode of Assessment

IAT / CCE / SEE

F. Scheme of Evaluation

2. Continuous Internal Evaluation (CIE): 50 Marks

Components	Average of 2 IATs	CCE	Total Marks
Max. Marks	20	30	50

Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50 marks).

2. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L3
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	PO										PSO				
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5
1	*												*		
2		*				*				*					
3			*			*					*				

4				*		*						*			
5			*		*	*									

8CSDS5251: DEEP LEARNING

. Course Framework

Credits: L-T-P-C: 3-0-0-3		**Syllabus Version: 1**
Contact Hours / Week: 3	**Total Contact Hours: 45**	**Level: 500**
Prerequisite : (If applicable)	A basic knowledge and programming experience in C language.	

Course Learning Objectives:

CLO1: To introduce students to the fundamental concepts in Deep Learning
CLO2: To introduce students to Neural Networks, how to train them and the challenges faced in training.
CLO3: To introduce different Deep Learning architectures like CNN, RNN and Sequence Model
CLO3: To discuss practical applications of Deep Learning

Course Outcomes: On successful completion of the course, students will be able to,

CO1: Understand the basic concepts of Deep Learning. (L2)
CO2: Know the basics of Neural networks, how to train them and challenges in training. (L2)
CO3: Understand various Deep learning architectures like CNN, RNN, Sequence model (L3)
CO4: Discuss the practical application of Deep Learning and where it fits in Industry (L4)
CO5: Analyze the real world problem and suggest solution to implement using Deep Learning (L4)

PO: PO1-PO4,PO7-PO10 **PSO**:PSO1 - PSO5

B. Syllabus

Module-1: Fundamentals of Deep Learning Hours: 9

Introduction: Introduction to Deep Learning, Definition and importance of deep learning, History and evolution of deep learning, Applications in various industries (e.g., healthcare, finance, autonomous driving).
Basics of Neural Networks: Biological inspiration and artificial neurons, Architecture of a neural network (layers, neurons, activation functions), Types of neural networks (feedforward, recurrent, convolutional)

Module-2: Training Neural Networks Hours: 9

Training Process: Introduction to training (forward and backward propagation), Loss functions and optimization (MSE, Gradient Descent, Adam).
Challenges in Training: Overfitting and underfitting, Regularization techniques (L1, L2, Dropout), Hyperparameter tuning and model validation.

Module-3: Deep Learning Architectures - Convolutional Neural Networks (CNNs) Hours:9

Introduction to CNNs: Understanding convolutions and pooling layers, CNN architecture and layer types, Applications of CNNs in image processing
Advanced CNN Concepts: Transfer learning and pre-trained models, Fine-tuning and feature extraction, Popular CNN architectures (LeNet, AlexNet, VGG, ResNet)

Module-4: Recurrent Neural Networks (RNNs) and Sequence Models Hours: 9

Basics of RNNs: Understanding sequential data and time series, RNN architecture, Limitations of RNNs (vanishing and exploding gradients) **Advanced Sequence Models**:Long Short-Term Memory (LSTM) and Gated Recurrent Units (GRUs), Attention mechanisms and Transformers,Applications in natural language processing (NLP)
Module-5: Practical Deep Learning and Industry Applications **Hours: 9**
Generative AI for Deep Learning: Overview of Generative Models (GANs, VAEs), Applications of Generative AI in Industry (art, design, data augmentation), Introduction to Transformers and Large Language Models (GPT, BERT) **Case Studies**: Use of Generative AI in real-world scenarios (chatbots, content creation)
C. References
1. Deep Learning From Scratch: Building with Python from First Principles by Seth Weidman published by O'Reilly 2. Generative Deep Learning by David Foster 3. Deep learning in Python/ Pytorch by Manning Publications
D. Mode of Assessment
IAT / CCE / SEE
E. Scheme of Evaluation

1. Continuous Internal Evaluation (CIE) : 50 Marks

Components	Average of 2 IAT's	CCE	Total Marks
Max.marks	20	30	50

2. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50)

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L2,L3,L4
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	**PO**										**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**
1	*										*				
2		*	*								*				
3	*	*	*												
4		*	*	*							*		*	*	
5		*	*	*			*	*	*	*		*	*	*	*

8CSGC6771 : DATA MINING		
. Course Framework		
Credits: L-T-P-C: 3-0-0-3		**Syllabus Version: 1**
Contact Hours / Week: 3	**Total Contact Hours: 45**	**Level:600**
Prerequisite: (If applicable)		

Course Learning Objectives:

CLO1:To develop skills of using recent data mining software for solving practical problems.

CLO2:To preprocess and analyze data.

CLO3: To choose relevant models and algorithms for respective applications.

CLO4: To develop research interest towards advances in data mining.

Course Outcomes: On successful completion of the course, Students will be able to,

CO1: Differentiate different types of data to be mined. (L2)

CO2: Categorize the scenario for applying different data mining techniques. (L3)

CO3: Evaluate different models used for classification and Clustering.(L3)

CO4: Focus towards research and innovation.(L4)

PO: PO1-PO4,PO6,PO10 **PSO**:PSO1 - PSO4

B. Syllabus

MODULE I: Introduction **Hours: 9**

Introduction: Data Mining – Kinds of data to be mined – Kinds of patterns to be mined – Technologies – Targeted Applications - Major Issues in Data Mining – Data Objects and Attribute Types – Measuring Data similarity and dissimilarity - Data Cleaning –Data Integration - Data Reduction – Data Transformation – Data Discretization.

Module:2: Data Warehousing & Online Analytical Processing **Hours:9**

Data warehousing and OLAP, ETL, data cube, data warehouse design and usage, data generalization, data cube technology, strategies for data cube computation, processing advanced kinds of queries, mining frequent patterns, associations and correlations.

Module:3: CLASSIFICATION TECHNIQUES **Hours:9**

Basic Concepts – Decision Tree Induction – Bayes Classification Methods – Rule-Based Classification – Model Evaluation and Selection – Techniques to Improve Classification Accuracy – Bayesian Belief Networks – Classification by Backpropagation – Support Vector Machine

Module:4: CLUSTERING TECHNIQUES **Hours : 9**

Cluster analysis, basic clustering methods, partitioning, hierarchical methods, density-based methods, evaluation of clustering, advanced cluster analysis, clustering high-dimensional data, clustering graph and network data, clustering with constraints
Module 5 : OUTLIER DETECTION AND APPLICATIONS Hours:9
Outliers and Outlier Analysis – Clustering-Based Approach – Classification-Based Approach – Mining Complex Data Types – Data Mining Applications.
C. References
[1] Jiawei Han, Micheline Kamber and Jian Pie, Data Mining Concept and Techniques, Morgan and Kaufmann Publisher, Third Edition, 2012. [2] Arun K Pujari, Data Mining Techniques, Second Edition, Universities Press India Pvt. Ltd. 2010.
D. Mode of Assessment
IAT / CCE / SEE
E. Scheme of Evaluation

1. Continuous Internal Evaluation (CIE): 50 Marks

Components	Average of 2 IATs	CCE	Total Marks
Max. Marks	20	30	50

2. Semester End Examination (SEE) Scheme: 100 Marks (Scaled down to 50 marks).

Section	No of Questions	No of Questions to be attempted	Marks / Question	Total Marks for the Section	Revised Bloom's Taxonomy
A	7	5	5	25	L2,L2,L4
B	6	4	15	60	L1, L2, L3, L4
C	1 (Case study)	1	15	15	L3, L4

F. CO-PO-PSO Mapping

CO-PO-PSO Mapping															
CO	**PO**										**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**
1	*												*		
2		*				*				*					
3			*			*					*				
4				*		*						*		*	

Career Effectiveness GPSBD1181		
A. Course Framework		
Credits: L-T-P-C: GR		**Syllabus Version: 1.0**
Contact Hours / Week: 2 hours per week	**Total Contact Hours: 15 hours**	**Level: 100**
Prerequisite: (If applicable)	**NIL**	
Course Learning Objectives:		
CL01: To apply effective strategies to enhance career readiness, including preparing for case studies, interviews, and group discussions. CL02: To develop and demonstrate effective presentation skills, grooming, and professional attire for corporate settings. CL03: To understand and apply corporate etiquette and professional conduct in various business environments. CL04: To develop and practise leadership skills and effective team management techniques including temperance and self-control.		
Course Outcomes: On successful completion of the course, Students will be able to:		
CO1:Demonstrate proficiency in analysing case studies, preparing for interviews, and actively participating in group discussions. (L3) CO2:Exhibit professional presentation skills and apply appropriate grooming and dress code in corporate settings. (L3) CO3:Practise corporate etiquette and display professional behaviour in diverse business situations. (L3) CO4:Develop leadership skills and effectively manage teams through hands-on experience and experiential learning with application of temperance and self-control. (L3)		
B. Syllabus		
Module:1: Prepare for Case Studies (PCS)		**Hours: 2 hours**

D. Continuous Internal Evaluation (CIE)

E. Scheme of Evaluation Components: CIE (CCE)

New Soft Skills	CCE (2 sets of MCQ's for 25 each)		Remarks
Evaluation	CCE-1	CCE-2	G
Column Identifier >	A	B	C
Max. Marks	25	25	50

Preparing for Aptitude Tests [UG 2/2]		
A. Course Framework Course Code: GPSBA1031		
Credits: L-T-P-C: NA – Graduate Requirement (GR)		**Syllabus Version: 1.0**
Contact Hours / Week: 2	**Total Contact Hours: 30**	**Level: 100**
Prerequisite: (If applicable)	**NA**	

Course Learning Objectives:

01: To build competence in aptitude skills (Quantitative, Logical Reasoning, and Verbal Ability).
02: To equip students with skills to ace further studies tests.
03: To develop problem-solving skills essential for employment.
04: To enable students' transit from the Campus to the Corporate environment.

Course Outcomes: On successful completion of the course, Students will be able to,

O1: Apply the concepts of averages, mixture, and alligations to calculate class /set relationship O2: Solve problems of permutations and probability

O3: Illustrate their conceptual knowledge of blood relationships

O4: Apply the concepts of coding and decoding to discern specific patterns from given data to solve problems.

O5: Solve problems of binary logic using concepts of contradictions and the Trigger Statement Approach O5: Illustrate their conceptual knowledge of para-jumbled statements
O5: Identify and make use of verbal analogies and basics of grammar

B. Syllabus

Module:1: Hours: 5

Average, Statistics, Permutation and Combination, Probability

1) Concepts and problems based on simple averages
2) Concepts and problems based on weighted averages
3) Difference between mean, median, and mode
4) Problems based on standard deviation and variance
5) Fundamental Principle of Counting
6) Difference and relationship between Permutations and Combinations
7) Problems based on Linear and Circular arrangement of objects
8) Problems based on the arrangement and selection of objects with or without repetition 9) Problems-based applications of combinations
10) Understanding terms like a random experiment, sample space, compliment, mutually exclusive events, and exhaustive events
11) Problems based on coins, dice, and cards
12) Problems based on conditional probability

Module:2: Hours: 5

Logical Reasoning- Clocks and Calendar, Blood Relationship, Crypt arithmetic

1) Concept of odd days in a calendar
2) Problems based on Clocks
3) To find a day of the week given date
4) Puzzles based on Calendar
5) Understanding various terms to define relationships
6) Learn to avoid gender and number assumptions in relationships
7) Learning to create a schematic diagram or family tree

8) Problems based on blood relationship
9) Introduction of Crypt arithmetic
10) Methods to solve Crypt arithmetic problems
11) Crypt arithmetic addition problems

Module:3: Hours: 5

Series, Coding and Decoding, Logical Connectives, Binary Logic

1) Concept of finding the next terms or missing terms in a series
2) Concept of finding odd terms in a series
3) Learning strategies to remember the place value of the alphabet
4) Number Series problems based on arithmetic sequence, harmonic sequence, Quadratic sequence, triangular sequence, etc.
5) Problems based on letter series
6) Short puzzles on coding and decoding
7) Crypt arithmetic addition problems
8) Understanding the logical connectors like If-Then, Only If-Then, Either-Or, etc.
9) Puzzles based on logical connectors
10) Concept of Truth-tellers, Liars, and Alternators

Module:4: Hours: 5

Para jumbled Statements, Statements, and Conclusions

1) Understanding para jumbles
2) Variations in para jumble questions
3) Tips and tricks to solve para jumble questions
4) Concluding the given statements

Module:5: Hours: 10

Reading Comprehension, Sentence Correction or Sentence Completion, Spotting Errors 1) Understanding the essentials of Reading Comprehension like fluency and vocabulary 2) Utilizing the three main types of reading - scanning, skimming, and in-depth reading 3) Applying strategies in Reading Comprehension, including activating, inferring, monitoring-clarifying, questioning, searching-selecting, summarizing, and visualizing-organizing 4) Strategies for deciding to arrive at the correct answer
5) Understanding sentence formation and spotting the errors in the sentence

C. References

1. Guha, A. (2016). *Quantitative Aptitude for Competitive Examination*. Tata McGraw-Hill. 2. Wren & Martin. (2017). *High School Grammar and Composition.* S-Chand Publishing. 3. Gupta, A.K. (2016). *Logical and Analytical Reasoning*. Ramesh Publishing House. 4. Aggarwal, R.S. (2017). *Quantitative Aptitude for Competitive Examination*. S-Chand Publishing. 5. Arun Sharma & Meenakshi Upadhyay. (2011). *How to Prepare for Verbal Ability and Reading Comprehension*. McGraw Hill

D. Mode of Assessment

CIE: IAT/ CCE

E. Scheme of Evaluation

GR	Courses (PAT / PATL)	IAT	CCE	CIE	SEE	Total	Evaluation	IAT	CCE-1	CCE-2	CCE-3	CCE-4	CCE-5	Total CCE (B to F)	Total CIE (IAT + CCE)	(A + G)	SEE	Grand Total (H + I)
Column Identifier >		A	B	C	D	E	F	G	H	I	J							
Max. Marks		NA	10	10	10	10	10	50	50	NA	50							

CURRICULUM GLOSSARY

Credit Distribution: Allocation of credits under lecture (L), tutorials (T), and practicals (P) viz. L-T-P-C. Eg. A 4 credit course has a credit distribution as 3-0-1-4 implying 3 credits for lecture and 1 credit for practicals and total of 4 credits

Program Core (Credit Courses):

Each academic programme is divided into mandatory and choice segments, with levels within them. Mandatory segments are those which lay a firm foundation of the knowledge required to complete a programme in the chosen domain, ending with a multifaceted assignment that serves as a culminating academic and intellectual experience for students, typically during their final year. Choice segments are those which a student could opt for to specialize further and / or to improve their interdisciplinary skills. All segments carry credits, and the students are expected to earn the minimum number of credits in their coursework towards program core during their academic programme. The Program Core courses are categorized as follows:

a. Foundation: A core course that must be satisfactorily completed in order to complete the requirements of the program. It lays the foundations for higher level courses. A foundation course assures that students are academically and personally ready to progress their degree. The foundation courses are further categorized as follows:

i. Fundamental: A required course you have to complete in order to enroll in a more advanced course. The prerequisite course usually teaches the basic information necessary to succeed in the more advanced course. It is the most basic or most important course on which other courses depend.

ii. Intermediate: Courses that are suitable for learners with some degree of skill or competence in that particular discipline area of study

iii. Advanced: Courses that involve higher and more complex levels of knowledge and understanding than introductory or foundational learning. It means the student has attained a level of knowledge and understanding of a particular area or topic that goes beyond basic terminology and definitions and is ready to be involved in Analysis, Synthesis and Evaluation of information related to a specific topic or area of learning.

b. Elective: A course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course. Elective courses can fall either under specialization or general category.

i. General: Courses that are designed to develop learners' general knowledge, skills and attitudes, often to prepare students for more advanced education programmes. General courses complement the more specialized learning undertaken in a student's chosen field of study and contribute to the flexibility which graduates are increasingly required to demonstrate.

ii. Specialization: A set of related courses which are structures for students to achieve specific learning outcomes. Specializations can be in a single discipline or multi-disciplinary. Specialization courses is a specified sequence of courses that equips one with specialized knowledge in one's discipline

c. Interdisciplinary: These are courses that are entirely outside of the program of study. One may take the course from other disciplines, as long as one meet the course requirements (prerequisites)

d. Mini Project: A mini project is considered as a special course involving application of knowledge gained from studying a particular discipline or a particular area of the program of study in solving / analyzing /exploring a real life situation / difficult problem. A process that fosters learners' engagement in studying authentic problems or issues centered on a particular project, theme, or idea. This process is inquiry-based, outcome-oriented, and associated with conducting the curriculum in real-world contexts.

e. Internship: An internship is a full-time or part-time work experience during the program study for which one earns course credit and may be paid or considered as volunteer work. Internships allow students to gain real-world experience, determine if they have an interest in a particular career and create a network of professional contacts.

g. Dissertation: An elective course designed to acquire special / advanced knowledge, which a student studies on his own with an advisory support by a faculty member. Dissertation is an ordered and critical exposition of existing knowledge in any field or part of a field of study and is expected to provide a good training for the student in R&D work and technical leadership.

g. Capstone project: A final course in a sequence of courses that provides an opportunity for students to integrate the knowledge and skills they have acquired. The learning outcomes of the capstone will normally map into the learning outcomes for the program. It is a substantial, compulsory project that consolidates one's learning and demonstrates that one has acquired the necessary skills and knowledge during the program of study. One usually completes it during the final year of your course.

Common Core (Credit Courses):

Students are expected to earn a certain specified number of credits in their coursework towards Common Core, during their academic programme. While some courses are in workshop mode, which can be completed over a few days at a stretch, there are other courses which are offered for a few hours per week throughout a semester. Students take these courses planned for each academic programme, over multiple semesters. Credits range from 1 to 4, which are directly proportional to the number of hours required to complete a course. There are both ‘mandatory’ and ‘choice’ courses, with levels within them.

Common Core (Non – Credit): Graduate Requirement:

Engagements under this category do not carry credits but are mandatory for the students to complete them during the academic programme, to be considered eligible to graduate / earn the degree.
These could be:
1. **Courses** embedded in the academic programme, where the students must ensure that they attend a minimum of 75% of the classroom hours and meet the assessment criteria, if any.
2. **Community Service activities** under which the students have to log a minimum number of hours in a semester by rendering certain prescribed services to the society and collect evidence from the concerned authority for having done so. A reflective presentation on the learning and experience gained, together with the impact on the society has to be submitted on completion of the required no. of hours as per the respective program.

Courses under various categories can be further classified as:

- **500 Level Courses**: These courses offer an introduction to a subject area and are designed for students in the first year of study. These courses are generally defining basic concepts or presenting the terminology of a discipline
- **600 Level Courses**: They are courses of advanced college-level difficulty offered for students clearly interested in the discipline or in any stream of the discipline. These units of study are advanced courses and are normally taken in the second year or later as the final elements of a two year degree or an integrated degree. The level indicates that the student will be demonstrating coherence and breadth or depth of knowledge and skills. The student may need to have completed a prerequisite course to study a 600 level course.

- **Prerequisite:** A prerequisite to ‘’Course X’’ is a course that must be successfully completed before the student can undertake ‘’Course X’