Department of Computer Engineering

VIVEKANAND EDUCATION SOCIETY'S
Institute of Technology
(An Autonomous Institute Affiliated to University of Mumbai, Approved by A.I.C.T.E. & Recognized by Govt. of Maharashtra)
Department of Computer Engineering

Program Structure for Fourth Year Computer Engineering Scheme for Autonomous Program (With Effect from 2025-2026)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract / Tut.	Theory	Pract	Total
CSC701	Machine Learning	3	--	3	--	3
CSC702	Big Data Analytics	3	--	3		3
CSDC701X	Department Level Optional Course-3	3	--	3	--	3
CSDC702X	Department Level Optional Course-4	3	--	3	--	3
ILO701X	Institute Level Optional Course-1	3	--	3	--	3
CSL701	Machine Learning Lab	--	2	--	1	1
CSL702	Big Data Analytics Lab	--	2	--	1	1
CSDL701X	Department Level Optional Course-3 Lab	--	2	--	1	1
CSDL702X	Department Level Optional Course-4 Lab	--	2	--	1	1
CSP701	Major Project I	--	6[$]	--	3	3
Total		**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam. Duration (in Hrs)			
		Mid Test (MT)	CA*					
CSC701	Machine Learning	20	20	60	2	--	--	100
CSC702	Big Data Analysis	20	20	60	2	--	--	100
CSDC701X	Department Level Optional Course-3	20	20	60	2	--	--	100
CSDC702X	Department Level Optional Course-4	20	20	60	2	--	--	100
ILO701X	Institute Level Optional Course-1	20	20	60	2	--	--	100
CSL701	Machine Learning Lab	--	--	--	--	25	25	50
CSL702	Big Data Analytics Lab	--	--	--	--	25	25	50
CSDL701X	Department Level Optional Course-3 Lab					25	-	25
CSDL702X	Department Level Optional Course-4 Lab	--	--	--	--	25	-	25
CSP701	Major Project 1	--	--	--	--	50	25	75
Total		**100**	**100**	**300**	--	**150**	**75**	**725**

* indicates Continuous Assessment

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract / Tut.	Theory	Pract	Total
CSC801	Distributed Computing	3	--	3	--	3
CSDC801X	Department Level Optional Course -5	3	--	3	--	3
CSDC802X	Department Level Optional Course -6	3	--	3	--	3
ILO801X	Institute Level Optional Course -2	3	--	3	--	3
CSL801	Distributed Computing Lab	--	2	--	1	1
CSDL801X	Department Level Optional Course -5 Lab	--	2	--	1	1
CSDL802X	Department Level Optional Course -6 Lab	--	2	--	1	1
CSP801	Major Project II	--	12[$]	--	6	6
Total		**12**	**18**	**12**	**9**	**21**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & Oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (in Hrs)			
		Mid Test (MT)	CA*					
CSC801	Distributed Computing	20	20	60	2	--	--	100
CSDC801X	Department Level Optional Course -5	20	20	60	2	--	--	100
CSDC802X	Department Level Optional Course -6	20	20	60	2	--	--	100
ILO801X	Institute Level Optional Course -2	20	20	60	2	--	--	100
CSL801	Distributed Computing Lab	--	--	--	--	25	25	50
CSDL801X	Department Level Optional Course -5 Lab	--	--	--	--	25	25	50
CSDL802X	Department Level Optional Course -6 Lab					25	25	50
CSP801	Major Project- 2	--	--	--	--	100	50	150
Total		**80**	**80**	**240**	--	**175**	**125**	**700**

* indicates Continuous Assessment
$ indicates workload of Learner (Not Faculty), students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1 hour per week per four groups.

Major Project 1 and 2 :

· Students can form groups with minimum 2 (Two) and not more than 4 (Four)
· Faculty Load : In Semester VII – ½ hour per week per project group
-In Semester VIII – 1 hour per week per project group

Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject
VII	Department Optional Course -3	CSDC7011: Machine Vision CSDC7012: Quantum Computing CSDC7013: Natural Language Processing
	Department Optional Lab -3	CSDL7011: Machine Vision Lab CSDL7012: Quantum Computing Lab CSDL7013: Natural Language Processing Lab
	Department Optional Course -4	CSDC7021 : Augmented and Virtual Reality CSDC7022 : Block Chain CSDC7023 : Information Retrieval
	Department Optional Lab -4	CSDL7021 : Augmented and Virtual Reality Lab CSDL7022 : BlockChain Lab CSDL7023 : Information Retrieval Lab
	Institute level Optional Courses-I	ILO7011. Product Lifecycle Management ILO7012. Reliability Engineering ILO7013. Management Information System ILO7014. Design of Experiments ILO7015. Operation Research ILO7016. Cyber Security and Laws ILO7017. Disaster Management & Mitigation Measures ILO7018. Energy Audit and Management ILO7019. Development Engineering

Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject
VIII	Department Optional Course-5	CSDC8011 : Deep Learning CSDC8012 : Digital Forensic CSDC8013 : Applied Data Science
	Department Optional Lab -5	CSDL8011 : Deep Learning Lab CSDL8012 : Digital Forensic Lab CSDL8013 : Applied Data Science Lab
	Department Optional Course -6	CSDC8021 : Optimization in Machine Learning CSDC8022: High Performance Computing CSDC8023: Social Media Analytics
	Department Optional Lab -6	CSDL8021 : Optimization in Machine Learning Lab CSDL8022: High Performance Computing Lab CSDL8023: Social Media Analytics Lab
	Institute level Optional Courses-II	ILO8021. Project Management ILO8022. Finance Management ILO8023. Entrepreneurship Development and Management ILO8024. Human Resource Management ILO8025. Professional Ethics and CSR ILO8026. Research Methodology ILO8027. IPR and Patenting ILO8028. Digital Business Management ILO8029. Environmental Management

Course Code	Course Title	Credit
CSC701	Machine Learning	3

Prerequisite: Engineering Mathematics, Data Structures, Algorithms	
Course Objectives	
1	To introduce the basic concepts and techniques of Machine Learning.
2	To acquire in depth understanding of various supervised and unsupervised algorithms
3	To be able to apply various ensemble techniques for combining ML models.
4	To demonstrate dimensionality reduction techniques.
Course Outcomes	
1	To acquire fundamental knowledge necessary for developing machine learning models.
2	To select, apply and evaluate an appropriate machine learning model for the given application.
3	To identify the classification problem and apply the SVM for classification purposes.
4	To demonstrate ensemble techniques to combine predictions from different models.
5	To apply the clustering methods for an appropriate application and demonstrate the dimensionality reduction techniques.
6	To emphasize on applying the knowledge to solve real world problems and study the latest trends.

Module	Content		Hours
1	**Introduction to Machine Learning**		03
	1.1	Machine Learning, Types of Machine Learning- Supervised, unsupervised and reinforcement, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application.	
	1.2	Training Error, Generalization error, Overfitting, Underfitting, Bias Variance trade-off	
2	**Learning with Regression**		06
	2.1	Learning with Regression: Linear Regression, Multivariate Linear Regression, Logistic Regression.	

	2.2	Performance Measures : Model evaluation and selection, Training, Testing and Validation Tests, Confusion Matrix & Basic Evaluation Metrics, Precision-recall.	
3	**Dimensionality Reduction**		**04**
	3.1	Curse of Dimensionality, Dimensionality Reduction Techniques, Principal Component Analysis, Linear Discriminant Analysis, Singular Value Decomposition.	
4	**Learning with Classification**		**06**
	4.1	Introduction to classification, Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index (Regression), Classification and Regression Trees (CART)	
	4.2	Introduction to Support Vector Machine (SVM), Hyperplane, Optimal decision boundary, Margins and support vectors, linear SVM, Nonlinear SVM, Kernelized SVM	
5	**Ensemble Learning**		**06**
	5.1	Understanding Ensembles, K-fold cross validation, Boosting, XGBoost	
	5.2	Bagging, Random Forest, Comparison with Boosting	
	Learning with Clustering		**08**
	5.3	Introduction to clustering with overview of distance metrics	
	5.4	Graph Based Clustering: Clustering with minimal spanning tree Model based Clustering: Expectation Maximization Algorithm, Density Based Clustering: DBSCAN	
6	**Current Trends and tools used in ML**		**06**
	6.1	Introduction to Reinforcement learning (RL), Elements of RL, Model based, Temporal based	
	6.2	Machine Learning projects handle different types of data and tools in industries of Health Care & Agriculture	
		Total	**39**

Textbooks	
1	Peter Harrington, ―Machine Learning n Action‖, DreamTech Press
2	Ethem Alpaydın, ―Introduction to Machine Learning‖, MIT Press
3	Tom M. Mitchell, ―Machine Learning‖ McGraw Hill

4	Stephen Marsland, ―Machine Learning An Algorithmic Perspective‖, CRC Press
References	
1	Han Kamber, ―Data Mining Concepts and Techniques‖, Morgan Kaufmann Publishers
2	Dr. Deepali Vora, Dr. Gresha Bhatia, Python for Machine Learning projects
3	Margaret. H. Dunham, ―Data Mining Introductory and Advanced Topics, Pearson Education
4	Kevin P. Murphy , Machine Learning ― A Probabilistic Perspective‖
5	Machine Learning For Absolute Beginners: A Plain English Introduction (Second Edition), Oliver Theobald
6	Richard Duda, Peter Hart, David G. Stork, ―Pattern Classification‖, Second Edition, Wiley Publications.
7	Approaching (Almost) Any Machine Learning Problem, Abhishek Thakur

Useful Links	
Resources	
1	https://archive.nptel.ac.in/courses/106/106/106106139/
2	https://onlinecourses.nptel.ac.in/noc23_cs87/preview
3	https://www.coursera.org/learn/machine-learning
4	https://www.coursera.org/specializations/machine-learning-introduction
5	Datasets for Machine Learning algorithms:https://www.kaggle.com/datasets
6	Machine Learning repository- https://archive.ics.uci.edu/
AI Tools	
1	https://www.datarobot.com/
2	https://h2o.ai/
3	https://altair.com/altair-rapidminer
4	https://mlflow.org/
5	https://wandb.ai/site
Industry Articles	

1	https://365datascience.com/trending/future-of-machine-learning/
2	https://towardsdatascience.com/machine-learning/home
3	https://www.datacamp.com/blog/category/machine-learning
Case Studies	
1	https://shorturl.at/BFgz3
2	https://shorturl.at/qTGL6
3	https://aws.amazon.com/blogs/machine-learning/category/case-study/
4	https://www.tableau.com/learn/articles/machine-learning-examples

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5
2	Literature review of papers/journals	5
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5
4	Wins in the event/competition/hackathon pertaining to the course	10
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10

11	Peer Review and participation	5/10
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable To complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

Course Code	Course Title	Credit
CSC702	Big Data Analytics	3

Prerequisite: Database, Data mining	
Course Objectives	
1	To provide an overview of the big data platforms, its use cases and Hadoop ecosystem.
2	To introduce programming skills to build simple solutions using big data technologies such as MapReduce, Scripting for No SQL and distributed processing using Spark
3	To learn the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4	To enable students to have skills that will help them to solve complex big data real-world problems for business.
5	To introduce data engineering concepts and techniques relevant to big data analytics.
Course Outcomes	
1	Understand the building blocks of Big Data Analytics.
2	Apply fundamental enabling techniques like Hadoop and MapReduce in solving real world problems.
3	Understand different NoSQL systems and how it handles big data
4	Apply advanced techniques for emerging applications like stream analytics
5	Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications, etc.
6	Gain knowledge and skills in data engineering concepts relevant to big data analytics and apply distributed processing techniques for analyzing big data

Module	Content		Hours
1	**Introduction to Big Data and Hadoop**		02
	1.1	Introduction to Big Data - Big Data characteristics and Types of Big Data	
	1.2	Traditional vs. Big Data business approach	
	1.3	Case Study of Big Data Solutions	
	1.4	Concept of Hadoop, Core Hadoop Components; Hadoop Ecosystem	

2	**Hadoop HDFS and MapReduce**		**08**
	2.1	Distributed File Systems: Physical Organization of Compute Nodes, Large Scale File-System Organization	
	2.2	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.	
	2.3	Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union ,Intersection, and Difference by MapReduce	
	2.4	Hadoop Limitations	
3	**NoSQL**		**08**
	3.1	Introduction to NoSQL, NoSQL Business Drivers	
	3.2	NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable)stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study	
	3.3	NoSQL solution for big data, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer	
4	**Mining Data Streams**		**10**
	4.1	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing	
	4.2	Sampling Data techniques in a Stream	
	4.3	Filtering Streams: Bloom Filter with Analysis	
	4.4	Counting Distinct Elements in a Stream,Count Distinct Problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements	
	4.5	Counting Ones in a Window: The Cost of Exact Counts,The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in theDGIM Algorithm	
5	**Data Engineering**		**04**
	5.1	Introduction to Data Engineering,Data Ingestion: Techniques and Best Practices,Data Storage and Management: Data Lakes, Data Warehouses, Data Processing Pipelines.	
	5.2	Lamda Architecture, Batch Processing, Stream Processing, Data Quality and Governance	

6	**Distributed Data Processing with Spark**		**07**
	6.1	Spark Basics, RDDs (Resilient Distributed Datasets) Functional Programming in Spark, working with spark,Pair RDDs, Machine Learning with MLlib.	
	6.2	SparkSQL and Data Frames,Machine Learning with MLlib, Developing and Deploying Spark Applications	
	6.3	Common Spark Use Cases, Iterative Algorithms in Spark Graph Processing and Analysis using, Apache Kafka , Apache Airflow	
		Total	**39**

Textbooks	
1	Cre Anand Rajaraman and Jeff Ullman ―Mining of Massive Datasets‖, Cambridge UniversityPress
2	Alex Holmes ―Hadoop in Practice‖, Manning Press, Dreamtech Press.
3	Dan Mcary and Ann Kelly ―Making Sense of NoSQL‖ – A guide for managers and the rest of us, Manning Press.
4	Learning Spark, by Karau, Konwinski, Wendell, and Zaharia
5	"Data Pipelines with Apache Airflow" by Bas P. Harenslak, Julian De Ruiter, and Maxime Beauchemin
References	
1	Bill Franks , ―Taming The Big Data Tidal Wave: Finding Opportunities In HugeData StreamsWithAdvancedAnalytics‖,Wiley
2	Chuck Lam, ―Hadoop inAction‖, Dreamtech Press
3	Jared Dean, ―Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners‖,Wiley India Private Limited, 2014.
4	Jiawei Han and Micheline Kamber, ―Data Mining: Concepts and Techniques‖, Morgan Kaufmann Publishers, 3rd ed, 2010.
5	Lior Rokach and Oded Maimon, ―Data Mining and Knowledge Discovery Handbook‖, Springer, 2nd edition,2010.
6	Ronen Feldman and James Sanger, ―The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data‖, Cambridge University Press, 2006.
7	Vojislav Kecman, ―Learning and Soft Computing‖, MITPress, 2010.

Useful LInks

1	https://nptel.ac.in/courses/106104189
2	https://www.coursera.org/specializations/big-data#courses
3	https://www.digimat.in/nptel/courses/video/106106169/L01.html
4	https://www.coursera.org/learn/nosql-databases#syllabus
5	https://www.coursera.org/learn/etl-and-data-pipelines-shell-airflow-kafka
AI Tools	
1	https://www.cloudera.com/products/stream-processing.html
2	https://www.cloudera.com/products/data-engineering.html
Industry Articles	
1	https://www.oracle.com/il/a/ocom/docs/top-22-use-cases-for-big-data.pdf
2	https://rb.gy/mxnsy3
3	https://airflow.apache.org/docs/apache-airflow/stable/core-concepts/overview.html
Datasets	
1	**https://www.kaggle.com/datasets**
2	**https://data.gov**
3	**https://github.com/awesomedata/awesome-public-datasets**
Case Studies	
1	**https://rb.gy/qhsh7p**
2	**https://rb.gy/3hdpe0**

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5

2	Literature review of papers/journals	5
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5
4	Wins in the event/competition/hackathon pertaining to the course	10
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10
11	Peer Review and participation	5/10
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

Course Code	Course Title	Credit
CSDC7011	Machine Vision	03

Prerequisite: Computer Graphics	
Course Objectives	
1	To understand the need and significance Machine Vision
2	To explore basics of image processing
3	To explore the components of Machine Vision System
4	To develop application using machine Vision
5	To study transformation, interpolation, filters
Course Outcomes	
1	Elaborate the components of Machine Vision Application
2	Perform image ,video preprocessing operations
3	Explain various transformations, interpolation
4	Elaborate motion tracking in video
5	Analyze and Implement appropriate filtering techniques for a given problem
6	Develop applications based on machine vision..

Module	Content		Hours
1	**Introduction to Machine Vision**		**04**
	1.1	Computer and Human Vision Systems., The Human Eye, Computer versus Human Vision Systems, Evolution of Computer Vision, Computer/Machine Vision and Image Processing, Applications of Computer Vision	
2	**Digital Image Fundamentals**		**08**
	2.1	Digital Image, Monochrome and Color Images, Image Brightness and Contrast., 2D, 3D, and 4D Images, Digital Image Representation, Digital Image File Formats, Fundamental Image Operations, Points, Edges, and Vertices , Point Operations , Thresholding ,Brightness, Geometric Transformations , Spatial Transformation , Affine Transformation, Image Interpolation ,Nearest-Neighbor Interpolation ,Bilinear Interpolation , Bi-cubic Interpolation ,Fundamental Steps in Digital	

		Image Processing.	
3	**Machine Vision and System Components**		**08**
	3.1	Machine Vision System, Machine Vision Camera: CCD and CMOS Image Sensors, TDI Sensor, Camera Type - Area Scan Cameras, Line Scan Cameras, Smart Cameras, Camera Lens Resolution, Contrast and Sharpness, Lenses and their parameters: Types of Lenses, Lens Mounts, Lens Selection Examples-Field of View Much larger than Camera sensor size or Smaller or close to Camera Sensor size, Machine Vision Lighting: Lighting: Light Sources in Machine Vision, Illumination Techniques-Backlighting, Front Lighting, Diffused Lighting, Oblique Lighting, Dark Field Lighting, Infrared and Ultraviolet Light, Filters, Machine Vision Software, Machine Vision Automation, Integration of Machine Vision Components	
4	**Digital Image Processing for Machine Vision Applications**		**10**
	4.1	Preprocessing., Image Filtering, Normalized Box Filter Gaussian Filter Bilateral Filter, Comparison of Filter Techniques, Sub sampling/Scaling Histogram, Image Segmentation, Threshold Based Segmentation Edge-Based Segmentation First-Order Derivative Edge Detection. Second-Order Derivative Operators, Comparison of Edge Detection Techniques, Region-Based Segmentation Region Growing Methods, Region Split and Merge Method, Morphological Image Processing: Dilation, Erosion, Opening, Closing, Hit-or-Miss transformation, Object Recognition. Template Matching. Blob Analysis	
5	**Motion Analysis**		**04**
	5.1	Differential motion Analysis, Optical Flow, Analysis based on correspondence of interest points, Detection of specific motion Patterns, Video Tracking	
6	**Emerging Trends in Machine Vision**		**05**
	6.1	History of Industrial Revolution(s), Machine Vision and Industry 4.0, Emerging Vision Trends in Manufacturing, 3D Imaging, Emerging Vision Trends in Manufacturing,	
	6.2	Applications in Machine/ Computer Vision: Face detection, face recognition, eigen faces, car on roads	
		Total	**39**

Textbooks	
1	Sheila Anand and L.Priya , ―A Guide for Machine Vision in Quality Control‖, Taylor & Francis Inc, Imprint CRC Press Inc, Dec 2019
2	Rafael C. Gonzalez and Richard E. Woods, ―Digital Image Processing‖, Pearson

Textbooks	
3	Carsten Stegar, Markus Ulrich, and Christian Wiedemann , ―Machine Vision Algorithms and Applications‖,Second completely Revised and Enlarged Edition
4	Milan Sonka, Vaclav Hlavac, Roger Boyle, ―Image Processing Analysis and Machine Vision‖, Second Edition, Cengage Learning.
Reference Books	
1	Chiranji Lal Chowdhary, Mamoun Alazab, Ankit Chaudhary, SaqibHakak and Thippa Reddy Gadekallu ,‖Computer Vision and Recognition Systems Using Machine and Deep Learning Approaches, Fundamentals, technologies and applications‖ , IET COMPUTING SERIES 42
2	Joe Minichino Joseph Howse ,‖Learning OpenCV 3 Computer Vision with Python‖, Second Edition, Packt Publishing Ltd.
3	Alexander Hornberg,, ― Handbook of Machine and Computer Vision The Guide for Developers and Users,
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc23_ee39/preview
2	https://onlinecourses.nptel.ac.in/noc19_cs58/preview
AI Tools	
1	https://cloud.google.com/vision
2	https://aws.amazon.com/rekognition/
Case Studies	
1	https://www.nvidia.com/en-us/about-nvidia/ai-computing/
2	https://www.tensorflow.org/tutorials/images

Internal Assessment

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4	Wins in the event/competition/hackathon pertaining to the course	10
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10
11	Peer Review and participation	5/10

*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

Indirect Assessment

1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture

End Semester Theory Examination

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
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4	Any three questions out of five need to be solved.

Course Code	Course Name	Credit
CSDC7012	Quantum Computing	03

Prerequisite: Engineering Mathematics, Data Structures and Algorithm, Python Programming	
Course Objectives	
1	To understand basics of quantum computing
2	To understand mathematics required for quantum computing
3	To understand building blocks of quantum computing and design algorithms
4	To understand quantum hardware principles and tools for quantum computing.
Course Outcomes: After successful completion of the course student will be able to	
1	Understand basic concepts of quantum computing
2	Illustrate building blocks of quantum computing through architecture and programming models.
3	Appraise various mathematical models required for quantum computing
4	Discuss various quantum hardware building principles.
5	Identify the various quantum algorithms
6	Describe usage of tools for quantum computing.

Module	Content		Hours
1	**Introduction to Quantum Computing**		07
	1.1	Motivation for studying Quantum Computing Origin of Quantum Computing Quantum Computer vs. Classical Computer Introduction to Quantum mechanics	
	1.2	Overview of major concepts in Quantum Computing Qubits and multi-qubits states Bloch Sphere representation Quantum Superposition Quantum Entanglement Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.)	
2	**Mathematical Foundations for Quantum Computing**		05

	2.1	Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.	
3	**Building Blocks for Quantum Program**		**08**
	3.1	Architecture of a Quantum Computing platform Details of q-bit system of information representation: Block Sphere Multi-qubits States Quantum superposition of qubits (valid and invalid superposition) Quantum Entanglement Useful states from quantum algorithmic perspective e.g. Bell State Operation on qubits: Measuring and transforming using gates.Quantum Logic gates and Circuit No Cloning Theorem and Teleportation	
	3.2	Programming model for a Quantum Computing Program Steps performed on classical computer Steps performed on Quantum Computer Moving data between bits and qubits	
4	**Quantum Algorithms and Error correction**		**06**
	4.1	Quantum Algorithms, Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch -Jozsa Algorithm	
	4.2	Quantum error correction using repetition codes 3 qubit codes, Shor's 9 qubit error correction Code	
5	**Quantum Hardware**		**10**
	5.1	Ion Trap Qubits, The DiVincenzo Criteria, Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating	
	5.2	Rotor Quantum Mechanics of a Free Rotor: A Poor Person's Atomic	
	5.3	Model: Rotor Dynamics and the Hadamard Gate, Two-Qubit Gates The Cirac-Zoller Mechanism:Quantum Theory of Simple Harmonic Motion, A Phonon-Qubit Pair Hamiltonian, Light-Induced Rotor-Phonon Interactions, Trapped Ion Qubits, Mølmer-Sørenson Coupling	
	5.4	Cavity Quantum Electrodynamics (cQED): Eigenstates of theJaynes-Cummings Hamiltonian Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms,Superconducting QubitsQuantum computing with spins:Quantum inverter realized with two exchange coupled spins in quantum dots, A 2-qubit spintronic universal quantum gate.	
6	**Quantum Mechanics of a Free Rotor:**		**03**
	6.1	IBM quantum experience Microsoft Q, Rigetti PyQuil (QPU/QVM)	
		Total	**39**

Textbooks	
1	Michael A. Nielsen, ―Quantum Computation and Quantum Information‖, Cambridge University Press.
2	David McMahon, ―Quantum Computing Explained‖, Wiley ,2008
3	Qiskit textbook https://qiskit.org/textbook-beta/
4	Vladimir Silva, Practical Quantum Computing for Developers,2018
References	
1	Bernard Zygelman, A First Introduction to Quantum Computing and Information,2018
2	Supriyo Bandopadhyay and Marc Cahy, ―Introduction to Spintronics‖, CRC Press, 2008
3	The Second Quantum Revolution: From Entanglement to Quantum Computing and Other Super-Technologies, Lars Jaeger
4	La Guardia, Giuliano Gladioli ―Quantum Error correction codes‖Springer,2021
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc21_cs103/preview
2	https://www.coursera.org/courses?query=quantum%20computing
3	https://www.cl.cam.ac.uk/teaching/1617/QuantComp/
AI Tools	
1	https://quantumai.google/
2	https://quantum.ibm.com/
3	https://github.com/qiskit

Internal Assessment		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
Sr. No	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5
2	Literature review of papers/journals	5
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5
4	Wins in the event/competition/hackathon pertaining to the course	10
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10
11	Peer Review and participation	5/10
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	

End Semester Theory Examination	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Course Title	Credit
CSDC7013	Natural Language Processing	03

Prerequisite: Theory of Computer Science, System Programming & Compiler Construction	
Course Objectives	
1	To define natural language processing and to learn various stages of natural language processing.
2	To describe basic concepts and algorithmic description of the main language levels: Morphology, Syntax, Semantics, and Pragmatics & Discourse analysis.
3	To design and implement various language models and POS tagging techniques.
4	To design and learn NLP applications such as Information Extraction, Question answering
5	To develop algorithms for semantic and pragmatic analysis tasks.
6	To learn advanced NLP techniques for developing real world NLP applications using LLM
Course Outcomes	
1	Have a broad understanding of the field of natural language processing
2	To design a language model for word level analysis for text processing
3	To design various POS tagging techniques and parsers
4	To design, implement and test algorithms for semantic and pragmatic analysis
5	To formulate the discourse segmentation and anaphora resolution
6	To Apply advanced NLP techniques with LLMs to solve real-world language processing challenges

Module		Content	Hours
1	**Introduction to NLP**		**03**
	1.1	Origin & History of NLP; Language, Knowledge and Grammar in language processing	
	1.2	Stages in NLP;Ambiguities and its types in English and Indian Regional Languages; Challenges of NLP;Applications of NLP	
2	**Word Level Analysis**		**08**
	2.1	Basic Terms: Tokenization, Stemming, Lemmatization; Survey of English	

		Morphology, Inflectional Morphology, Derivational Morphology;	
	2.2	Morphological Models: Dictionary lookup, finite state morphology; Morphological parsing with FST (Finite State Transducer)	
	2.3	Grams and its variation: Bigram, Trigram; Simple (Unsmoothed) N-grams; N-gram Sensitivity to the Training Corpus; Unknown Words: Open versus closed vocabulary tasks; Evaluating N-grams: Perplexity; Smoothing:Laplace Smoothing	
3	**Syntax analysis**		**08**
	3.1	Part-Of-Speech tagging(POS); Tag set for English (Upenn Treebank); Difficulties /Challenges in POS tagging; Rule-based, Stochastic and Transformation-based tagging;	
	3.2	Generative Model: Hidden Markov Model /HMM Viterbi for POS tagging; Issues in HMM POS tagging; Discriminative Model: Maximum Entropy model, Conditional random Field (CRF); Parsers	
4	**Semantic Analysis**		**06**
	4.1	Introduction, meaning representation; Lexical Semantics; Corpus study; Study of Various language dictionaries like WorldNet	
	4.2	Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy;Semantic Ambiguity; Word Sense Disambiguation (WSD);Knowledge based approach(Lesk's Algorithm)	
5	**Pragmatic & Discourse Processing**		**04**
	5.1	Discourse: Reference Resolution, Reference Phenomena, Syntactic & Semantic constraint on coherence, Anaphora	
6	**Generative AI , Prompt Engineering and Large Language Models**		**10**
	6.1	Introduction to Generative AI , Types of Generative AI Models (Variational AutoEncoders, Generative Adversarial Networks), Advantages and limitations of Generative AI,ChatGPT.	
	6.2	Prompt Engineering prompts for LLM interaction, Prompt Templates,Techniques for crafting clear, concise, and informative prompts, Exploring advanced prompt engineering strategies (zero-shot learning, few-shot learning) , and case studies: successful applications of prompt engineering.	
	6.3	LLM architecture (transformers), understanding pre-training and fine-tuning of LLM, Popular LLM examples (GPT-3),Exploring LLM capabilities: text generation, translation, question answering, code generation etc ,Langchain, Setting up Environment LangChain and LLM, Meta Llama2 , Google PaLM2 LLM	
		Total	**39**

Textbooks	
1	Daniel Jurafsky, James H. Martin "Speech and Language Processing" Second Edition, Prentice Hall, 2008.
2	Christopher D.Manning and Hinrich Schutze, " Foundations of Statistical Natural Language Processing ", MIT Press, 1999.
3	Natural Language Processing with Transformers: Revised Edition by Lewis Tunstall, Leandro von Werra, and Thomas Wolf
4	Prompt Engineering and ChatGPT , Russel Grant (Author), Jeremy Diener
References	
1	Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2	Daniel M Bikel and ImedZitouni — Multilingual natural language processing applications: from theory to practice, IBM Press, 2013.
3	Alexander Clark, Chris Fox, Shalom Lappin — The Handbook of Computational Linguistics and Natural Language Processing, John Wiley and Sons, 2012.
4	Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing,Second Edition, Chapman and Hall/CRC Press, 2010.
5	Niel J le Roux and SugnetLubbe, A step by step tutorial: An introduction into R application and programming.
6	Steven Bird, Ewan Klein and Edward Loper, Natural language processing with Python: analyzing text with the natural language toolkit, O Reilly Media, 2009.
Useful Links	
1	https://www.coursera.org/learn/natural-language-processing-tensorflow
2	https://nptel.ac.in/courses/106/105/106105158
3	https://www.coursera.org/learn/generative-ai-with-llms
4	https://onlinecourses.nptel.ac.in/noc19_cs56/preview
5	https://promptengineering.org/
6	https://www.deeplearning.ai/courses/natural-language-processing-specialization/

AI tools	
1	AllenNLP https://allenai.org/allennlp/software/allennlp-library, FLAX https://github.com/google/flax,
2	https://docs.aws.amazon.com/managedservices/latest/userguide/comprehend.html
3	https://www.mindmeld.com/
Case Study	
1	https://huggingface.co/docs/hub/en/transformers
2	https://paperswithcode.com/task/natural-language-understanding
Industry article	
1	Multilingual Chatbot using llm: https://arxiv.org/abs/2108.13349
2	https://huggingface.co/models
3	https://openai.com/news/research/
Dataset	
1	**https://huggingface.co/datasets**
2	**https://www.kaggle.com/discussions/general/150720**
3	**https://archive.ics.uci.edu/datasets**

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5
2	Literature review of papers/journals	5
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5
4	Wins in the event/competition/hackathon pertaining to the course	10

5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10
11	Peer Review and participation	5/10
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

Course Code	Course Title	Credit
CSDC7021	Augmented and Virtual Reality	3

Prerequisite: Computer Graphics	
Course Objectives	
1	To understand the need and significance of Virtual Reality.
2	To explore the concepts of Virtual reality and develop 3D virtual environments.
3	To understand the technical and engineering aspects of virtual reality systems.
4	To analyze various techniques for applying virtual reality.
5	To provide a foundation to the fast growing field of AR and make the students aware of the various AR devices.
Course Outcomes	
1	Describe how VR systems work and list the applications of VR
2	Elaborate geometric presentation of the virtual world and its operations.
3	Explain the concepts of motion and tracking in VR systems.
4	Design and implementation of the hardware that enables VR systems tobe built
5	Describe how AR systems work and analyze the hardware requirement of AR
6	Analyze and understand the working of various state of the art AR devices.

Module	Content	Hours
1	**Introduction to Virtual Reality**	**05**
	What is virtual reality? ,The beginnings of VR , VR paradigms , Collaboration, Virtual reality systems, Representation ,User interaction	
2	**The Geometry of Virtual Worlds**	**06**
	Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations	
3	**Motion in Real and Virtual Worlds**	**06**
	Velocities and Accelerations , The Vestibular System , Physics in the Virtual	

	World , Mismatched Motion and Vection	
4	**Applying Virtual Reality**	**07**
	Virtual reality: the medium, Form and genre, What makes an application a good candidate for VR, Promising application fields, Demonstrated benefits of virtual reality , More recent trends in virtual reality application development, A framework for VR application development	
5	**Augmented Reality**	**08**
	Terminology, Simple augmented reality, Augmented reality as an emerging technology, Augmented reality applications, Marker detection, Marker pose, Marker types and identification: Template markers, 2D bar-code markers, Imperceptible markers: Image markers, Infrared markers, Miniature markers, Discussion on marker use, General marker detection application	
6	**AR Development & Applications**	**07**
	User interfaces, Avoiding physical contacts , Practical experiences with head-mounted displays , Authoring and dynamic content ,AR applications and future visions, How to design an AR application ,Technology adoption and acceptance , Where to use augmented reality	
	Total	**39**

Textbooks	
1	Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2	Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)‖. Morgan Kaufmann Publishers, San Francisco, CA, 2002
3	Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig,William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.
4	Theory and applications of marker-based augmented reality SanniSiltanen
Reference Books	
1	AR Game Development‖, 1st Edition,Allan Fowler, A press Publications, 2018, ISBN 978-1484236178
2	Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
3	Learning Virtual Reality, Tony Parisi,O'Reilly Media, Inc., 2015, ISBN- 9781491922835

Digital Useful Links	
1	https://freevideolectures.com/course/3693/virtual-reality
2	https://www.vrlabacademy.com/

3	https://arvr.google.com/ar/
4	https://konterball.com/

Internal Assessment		
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Continuous Assessment		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
Sr. No	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5
2	Literature review of papers/journals	5
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5
4	Wins in the event/competition/hackathon pertaining to the course	10
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10
11	Peer Review and participation	5/10
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

Course Code	Course Title	Credit
CSDC7022	Blockchain	3

Prerequisite: Cryptography and System Security	
Course Objectives	
1	Understand blockchain platforms and its terminologies.
2	Understand the use of cryptography required for blockchain
3	Understand smart contracts, wallets, and consensus protocols.
4	Design and develop blockchain applications.
Course Outcomes	
1	Explain blockchain concepts
2	Apply cryptographic hash required for blockchain
3	Apply the concepts of smart contracts for an application.
4	Design a public blockchain using Ethereum.
5	Design a private blockchain using Hyperledger
6	Use different types of tools for blockchain applications.

Module	Content		Hours
1	**Introduction to Blockchain**		**04**
	1.1	What is a blockchain, Origin of blockchain (cryptographically secure hash functions), Foundation of blockchain: Merkle trees	
	1.2	Components of blockchain, Block in blockchain, Types: Public, Private, and Consortium, Consensus Protocol, Limitations and Challenges of blockchain	
2	**Cryptocurrency**		**08**
	2.1	Cryptocurrency: Bitcoin, Altcoin, and Tokens (Utility and Security), Cryptocurrency wallets: Hot and cold wallets, Cryptocurrency usage, Transactions in Blockchain, UTXO and double spending problem	
	2.2	Bitcoin Blockchain, Consensus in Bitcoin, Proof of Work (PoW), Proof of Burn(PoB), Proof of Stake (PoS), Proof of Elapsed Time (PoET), Life of a miner, Mining Difficulty, Mining Pools and its methods	
3	**Programming for Blockchain**		**08**

	3.1	Introduction to Smart Contracts, Types of Smart Contracts, Structure of a Smart Contract, Smart Contract Approaches, Limitations of Smart Contracts	
	3.2	Introduction to Programming: Solidity Programming – Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Inheritance, Error handling	
	3.3	Case Study – Voting Contract App, Preparing for smart contract development	
4	**Public Blockchain**		**08**
	4.1	Introduction to Public Blockchain, Ethereum and its Components, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transaction, Accounts, Architecture and Workflow, Comparison between Bitcoin and Ethereum	
	4.2	Types of test-networks used in Ethereum, Transferring Ethers using Metamask, Mist Wallet, Ethereum frameworks, Case study of Ganache for Ethereum blockchain, Exploring etherscan.io and ether block structure	
5	**Private Blockchain**		**08**
	5.1	Introduction, Key characteristics, Need of Private Blockchain, Smart Contract in a Private Environment, State Machine Replication, Consensus Algorithms for Private Blockchain - PAXOS and RAFT, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT**,** Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT	
	5.2	Introduction to Hyperledger, Tools and Frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & Other Technologies.	
6	**Tools and Applications of Blockchain:**		**03**
	6.1	Blockchain in Action: Use Cases Financial Services, Insurance, Government, Supply Chain Management, Healthcare, Healthcare payments pre-authorization, The Internet of Things (IoT)	
		Total	**39**

Textbooks	
1	Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhilash K. A and Meena Karthikeyen, Universities Press.
2	Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3	Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Packt Publishing
4	"Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN", 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491954386.
5	"Blockchain for Enterprise Application Developers", Ambadas, Arshad SarfarzAriff, Sham – Wiley
Reference Books	
1	Blockchain for Beginners, Yathish R and Tejaswini N, SPD
2	Blockchain Basics, A non Technical Introduction in 25 Steps, Daniel Drescher, Apress.
3	Blockchain with Hyperledger Fabric,Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing

Digital Useful Links	
1	Blockchain By Example, Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, November 2018, Implement decentralized blockchain applications to build scalable Dapps.
2	Blockchain for Business, https://www.ibm.com/downloads/cas/3EGWKGX7
3	https://www.hyperledger.org/use/fabric
4	NPTEL: https://onlinecourses.nptel.ac.in/noc19_cs63/preview
AI Tools	
1	**GitHub Copilot**: https://github.com/features/copilot
2	**DeepCode**: https://snyk.io/platform/deepcode-ai/
Case Studies	
1	https://www.accenture.com/in-en/case-studies/about/blockchain-contracts-harnessing-new-technology
2	https://www.samsungsds.com/in/case-study/list/blockchain-casestudy.html

Internal Assessment

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4	Wins in the event/competition/hackathon pertaining to the course	10
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10
11	GATE Based Assignment test/Tutorials etc	10
12	Peer Review and participation	5/10

*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

Indirect Assessment

1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture

End Semester Theory Examination

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Course Title	Credit
CSDC7023	Information Retrieval	03

Prerequisite	
Course Objectives	
1	To learn the fundamentals of Information Retrieval
2	To analyze various Information retrieval modeling techniques
3	To understand query processing and its applications
4	To explore the various indexing and scoring techniques
5	To assess the various evaluation methods
6	To analyze various information retrieval for real world application
Course Outcomes	
1	Define and describe the basic concepts of the Information retrieval system.
2	Design the various modeling techniques for information retrieval systems.
3	Understand the query structure and various query operations
4	Analyzing the indexing and scoring operation in information retrieval systems
5	Perform the evaluation of information retrieval systems
6	Analyze various information retrieval for real world application

Module	Content		Hours
1	**Introduction to Information Retrieval**		**04**
	1.1	Introduction to Information Retrieval, Basic Concepts, Information Versus Data, Trends and research issues in information retrieval	
	1.2	The retrieval process, Information retrieval in the library, web and digital libraries.	
2	**Modeling in Information Retrieval**		**08**
	2.1	Taxonomy of Information Retrieval models, Classic Information Retrieval, Alternate set: Theoretical model, Alternative Algebraic models, Alternative Probabilistic models	
	2.2	Structured text Retrieval models, Models for browsing	

3	**Query and Operations in Information Retrieval**		**08**
	3.1	Query structures, Keyboard based querying, Pattern matching, Structured queries	
	3.2	User relevance feedback, Automatic local analysis, Automatic global analysis	
4	**Indexing and Scoring in Information Systems**		**08**
	4.1	Introduction, Inverted Files, Other Indices for Text, Boolean queries and Introduction to Sequential searching	
	4.2	Scoring, term weighting and the vector space model, Parametric and zone indexes, Weighted zone scoring, Learning weights, The optimal weight, Term frequency and weighting, Inverse document frequency, Tf-idf weighting. The vector space model for scoring, Queries as vectors, Computing vector scores, Efficient scoring and ranking, Inexact top K document retrieval	
5	**Evaluation of Information Retrieval Systems**		**06**
	5.1	Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing and justifying the concept of relevance	
	5.2	System quality and user utility, System issues, Refining a deployed system	
6	**Applications of Information Retrieval Systems**		**05**
	6.1	Introduction to Multimedia Information Retrieval	
	6.2	Introduction to Distributed Information Retrieval	
		Total	**39**

Textbooks	
1	Modern information retrieval, Baeza-Yates, R. and Ribeiro-Neto, B., 1999. ACM press.
2	Introduction to Information Retrieval By Christopher D. Manning and PrabhakarRaghavan, Cambridge University Press
3	Information Storage & Retrieval By Robert Korfhage – John Wiley & Sons
References	
1	Storage Network Management and Retrieval, Vaishali Khairnar
2	Introduction to Modern Information Retrieval. G.G. Chowdhury. NealSchuman

Textbooks	
3	Natural Language Processing and Information Retrieval by Tanveer Siddiqui, U.S Tiwarey
Useful Links	
1	**CourseraText Retrieval and Search Engines**: https://www.coursera.org/learn/text-retrieval
2	**Stanford University's CS 276: Information Retrieval and Web Search**: http://cs276.stanford.edu/
3	**Academic Papers on Information Retrieval**: https://arxiv.org/abs/2301.08801
AI Tools	
1	**Coursera's "Introduction to Retrieval-Augmented Generation (RAG)"**: https://www.coursera.org/projects/introduction-retrieval-augmented-generation-rag
2	**DeepLearning.AI's "Building and Evaluating Advanced RAG Applications"**: https://www.deeplearning.ai/short-courses/building-evaluating-advanced-rag/

Internal Assessment

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Continuous Assessment

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5
2	Literature review of papers/journals	5
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4	Wins in the event/competition/hackathon pertaining to the course	10
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10

9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10
11	Peer Review and participation	5/10
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

Course Code	Course Title	Credit
ILO7011	Product Life Cycle Management	3

Prerequisite	
Course Objectives	
1	To familiarize the Learner with the need, benefits, and components of PLM
2	To Enable the learners to product design and development processes.
3	To acquaint Learner with Product Data Management & PLM strategies
4	To give insights into new product development program and guidelines for designing and developing a product
5	To familiarize the Learner with Virtual Product Development
6	To familiarize the Learner with design for environments, Life cycle assessment.
Course Outcomes	
1	Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study.
2	Illustrate various approaches and techniques for designing and developing products.
3	Apply product engineering guidelines / thumb rules in designing products.
4	Understand the concept of product data ,product data management and PDM implementation.
5	Understand and illustrate the concept of product design for the environment and life cycle assessment.
6	Acquire knowledge in applying virtual product development tools

Module	Content		Hours
1	**Introduction to Product Lifecycle Management (PLM)**		**08**
	1.1	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, spread of PLM, Focus and Application	
	1.2	PLM Strategies: Industrial strategies, Strategy elements, Developing PLM Vision and PLM Strategy , Change management for PLM	
2	**Product Design**		**10**
	2.1	Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model,	

	2.2	Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management,	
	2.3	The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
3	**Product Data Management (PDM)**		**05**
	3.1	Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system	
	3.2	Financial justification of PDM, barriers to PDM implementation	
4	**From sustainable Development to design for environment**		**06**
	4.1	Sustainable Development, Key factors in sustainable Development**,** Design for Environment	
	4.2	The Environment driving PLM- External Drivers: scale, Complexity , cycle times, globalization, regulations , Internal Drivers- Productivity innovation, collaboration, quality. Boardroom Driver-IT Value Map: income, revenue, costs. Comparing lean manufacturing, ERP,CRM and PLM	
5	**Life Cycle Assessment and Life Cycle Cost Analysis**		**06**
	5.1	Premises**,**Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment.	
	5.2	Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	
6	**Virtual Product Development Tool**		**04**
	6.1	Introduction VPD, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies.	
		Total	**39**

Reference Books	
1	John Stark, ―Product Lifecycle Management: Paradigm for 21st Century Product Realisation‖, Springer-Verlag, 2004. ISBN: 1852338105
2	Fabio Giudice, Guido La Rosa, Antonino Risitano, ―Product Design for the environment- A life cycle approach‖, Taylor & Francis 2006, ISBN: 0849327229
3	Saaksvuori Antti, Immonen Anselmie, ―Product Life Cycle Management‖, Springer, Dreamtech, ISBN: 3540257314
4	Michael Grieve, ―Product Lifecycle Management: Driving the next generation of lean thinking‖, Tata McGraw Hill, 2006, ISBN: 0070636265
Useful Links	
Resources	
1	https://www.oracle.com/in/scm/product-lifecycle-management/what-is-plm/
2	https://theproductmanager.com/tools/plm-software/
Case Studies	
1	https://www.dfki.de/fileadmin/user_upload/import/10289_2019-PLM_JS_Book_chapter_acamarillo_jrios_kdalthoff.pdf
2	https://www.sap.com/india/products/scm/plm-r-d-engineering/what-is-product-lifecycle-management.html

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No.	Rubrics	Marks
1	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10
2	Wins in the event/competition/hackathon	10
3	Content beyond syllabus presentation	10
4	Creating Proof of concept	10
5	Mini Project / Extra Experiments/ Virtual Lab etc	10

6	Case based Assignment/test/Tutorials etc	10
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5
8	Multiple Choice Questions (Quiz)	5
9	Peer review and Participation	10
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

Course Code:	Course Title	Credit
ILO7013	Management Information System	03

Prerequisite	
Course Objectives	
1	To discuss the roles played by information technology in today's business.
2	To understand the Intelligent Techniques for Data Analytics.
3	To determine ethical and privacy issues in management systems.
4	To understand the requirements for various Business Operations
5	To define various technologies on which information systems are built
6	To determine the types of systems used for enterprise-wide knowledge management and the way they provide value for businesses.
Course Outcomes: Learner will be able to understand	
1	The impact of information systems on an organisation's growth.
2	The principal tools and technologies for accessing information from databases to improve business performance and decision making.
3	The ethical frameworks and security concerns in information systems.
4	The various business models used for social computing.
5	IT infrastructure and its components and its current trends
6	Various enterprise-wide knowledge management systems and its functionalities.

Module	Content	Hours
1	**Introduction to Information Systems (IS)**	**04**
	Computer Based Information Systems, Impact of IT on organisations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	
2	**Database and Business Intelligence**	**08**
	Database Approach, Big Data, Data warehouse and Data Marts, Managing data resources:establishing an information policy, ensuring data quality Business intelligence (BI):-Decision Making Process, BI for Data analytics and Presenting Results	
3	**Ethical and Social Issues in Information Systems**	**06**

	Ethical issues and Privacy, Information Security. Threat to IS, and Security Controls	
4	**Social Computing (SC)**	**07**
	SC in business-shopping, Marketing, Operational and Analytical CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	
5	**Emerging Technologies**	**07**
	The Emerging Mobile Digital Platform: Consumerization of IT and BYOD (Bring Your Own Device), Grid Computing, Virtualization, Cloud Computing, Green Computing, High-Performance and Power-Saving Processors, Autonomic Computing Contemporary Software Platform Trends: Web Services and Service-Oriented Architecture, Software Outsourcing and Cloud Services Management Issues: Dealing with Platform and Infrastructure Change Management and Governance	
6	**Information System within Organization**	**07**
	Knowledge management System, Knowledge management value chain, Decision Support System, Transaction Processing Systems, ERP and ERP support of Business Process.	
	Total	**39**

Textbooks	
1	Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2	K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 13th Ed. © Pearson Education Limited 2014
References	
1	MIS: Management Perspective, D.P. Goyal, Vikas Publishing House Pvt. Ltd, 4th Edition.
2	D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008.
Useful Links	
1	Text Book
2	PPTs (Rainer) PPTs Lauden and Lauden
White Papers/ Case Studies	
1	Information System at Mcdonalds CASE
2	Providing Access to Electricity CASE

3	Benefits of MIS Integration (White paper)
4	Customer Experience Innovation WHITE pater

Internal Assessment		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
Sr. No	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	10
2	Publication in SCI , IEEE, UGC Care Listed Journal	10
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	10
4	Wins in the event/competition/hackathon pertaining to the course	10
5	Project based Learning and evaluation / Extra assignment / Question paper solution	10
6	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
7	Content beyond syllabus presentation (Special Topic Seminar)	10
8	Creating Proof of Concept i.e to design and develop a suitable Information System	10
9	Peer review and Participation	10
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

Course Code	Course Title	Credit
ILO7016	Cyber Security and Laws	3

Prerequisite	
Course Objectives	
1	To understand and identify different types cybercrime and cyber law
2	To recognized Indian IT Act 2008 and its latest amendments
3	To learn various types of security standards compliances
Course Outcomes	
1	To be able to understand the history of cyber crime and the need for cyber law.
2	To be able to recognise various types of cyber crimes and related security issues
3	To be able to identify the tools and methods used in cyber crime
4	To be able to discuss the need for cyber space for transactions and interactions
5	To be able to appreciate the evolution of IT act.
6	To be able to interpret the necessity of information security standards and compliances.

Module		Content	Hours
1	**Introduction to Cybercrime**		**04**
	1.1	Cybercrime definition, history and threats to security goals, Classifications of cybercrime, How criminal plan the attacks	
	1.2	The Need for an Indian Cyber Law, Introduction to Indian ITA 2000	
2	**Cyber frauds and Security issues**		**04**
	2.1	Social Engg, Cyber stalking, Online Drug Trafficking, Botnets, Attack vector, Credit Card Frauds in Mobile and Wireless Computing Era	
	2.2	Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, work from home cybersecurity Tips and Risks	
	2.3	Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	
		Self Learning Topics: Types of Cyber Frauds and security issues	

3	**Tools and Methods Used in Cybercrime**		**10**
	3.1	Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography	
	3.2	DoS and DDoS Attacks, SQL Injection, Buffer OverFlow,	
	3.3	Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	
4	**The Concept of Cyberspace**		**07**
	4.1	E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law	
	4.2	The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking	
5	**Indian IT Act**		**08**
	5.1	Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	
		Self Learning Topics: Case Studies	
6	**Information Security Standard compliances**		**06**
	6.1	SOX, HIPAA, ISO	
		Self Learning Topics: FISMA, NERC, PCI, GLBA	
		Total	**39**

Textbooks	
1	Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi 2 3
2	Cyber Security and Lawas, Madhumati Chatterjee, Sangita Chaudhary, Gaurav Sharma, Staredu solutions
3	Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
Reference Books	
1	The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
2	The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi
3	Nina Godbole, Information Systems Security, Wiley India, New Delhi

4	Kennetch J. Knapp, Cyber Security & Global Information Assurance Information Science Publishing.
5	William Stallings, Cryptography and Network Security, Pearson Publication
Useful Links	
1	The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
2	A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer- professionals-33538

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10
2	Wins in the event/competition/hackathon	10
3	Content beyond syllabus presentation	10
4	Creating Proof of concept	10
5	Mini Project / Extra Experiments/ Virtual Lab	10
6	GATE Based Assignment test/Tutorials etc	10
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5
8	Multiple Choice Questions (Quiz)	5
9	Peer Review and participation	5/10

End Semester Theory Examination	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Lab Code	Lab Name	Credit
CSL701	Machine Learning Lab	1

Prerequisite: Data Structures, Analysis of Algorithms	
Lab Objectives	
1	To implement an appropriate machine learning model for the given application.
2	To acquire an in-depth understanding of various supervised and unsupervised algorithms.
3	To apply various ensemble techniques for combining ML models
4	To apply various ensemble techniques for combining ML models
Lab Outcomes	
1	To study and use different methods of data visualization in machine learning.
2	To study and apply various regression techniques.
3	To implement ensemble techniques to combine predictions from different models.
4	To identify and implement suitable classification technique for a given problem
5	To apply and use different clustering techniques and dimension reduction methods.
6	To apply knowledge for solving real world problems across various domains.

Suggested Experiments: Students are required to complete at least 8 experiments.	
Sr. No.	**Name of the Experiment**
1	To study and implement different data visualization methods..
2	To apply Linear Regression for prediction purposes and estimate the errors associated with it.
3	To identify the classification problem which can be solved using trees, evaluate the performance measures.
4	To use Support Vector Machine to solve the classification problem and evaluate the performance measure
5	To implement Ensemble Learning(bagging/boosting) for complex pattern recognition tasks
6	To study and implement Multivariate Regression
7	To use DBSCAN/K Means clustering for an appropriate problem statement
8	To apply PCA/SVD for dimension reduction
9	To implement a Mini project for solving a real world problems in domain agriculture, energy, healthcare or any other domain for societal use

Useful Links	
Resources	
1	https://archive.nptel.ac.in/courses/106/106/106106139/
2	https://onlinecourses.nptel.ac.in/noc23_cs87/preview
3	https://www.coursera.org/learn/machine-learning
4	https://www.coursera.org/specializations/machine-learning-introduction
5	Datasets for Machine Learning algorithms:https://www.kaggle.com/datasets
6	Machine Learning repository- https://archive.ics.uci.edu/
AI Tools	
1	https://www.datarobot.com/
2	https://h2o.ai/
3	https://altair.com/altair-rapidminer
4	https://mlflow.org/
5	https://wandb.ai/site
Industry Articles	
1	https://365datascience.com/trending/future-of-machine-learning/
2	https://towardsdatascience.com/machine-learning/home
3	https://www.datacamp.com/blog/category/machine-learning
Case Studies	
1	https://shorturl.at/BFgz3
2	https://shorturl.at/qTGL6
3	https://aws.amazon.com/blogs/machine-learning/category/case-study/
4	https://www.tableau.com/learn/articles/machine-learning-examples

Term Work	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSL701and CSC701

Lab Code	Lab Name	Credit
CSL702	Big Data Analytics Lab	1

Prerequisite: C Programming Language.	
Lab Objectives	
1	Solve Big Data problems using Map Reduce Technique and apply to various algorithms.
2	Identify various types of NoSQL databases and execute NOSQL commands
3	Understand implementation of various analytic techniques using Hive/PIG/Spark etc.
4	Apply streaming analytics to real time applications.
Lab Outcomes	
1	To interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
2	To implement algorithms that uses Map Reduce to apply on structured and unstructured data
3	To perform hands-on NoSql databases such as Cassandra, HadoopHbase, MongoDB, etc.
4	To implement various data streams algorithms.
5	To develop big data analytics applications using Apache Kafka, Apace Airflow, Spark
6	To apply knowledge for solving real world big data problems across various domains

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	Hadoop HDFS Practical: -HDFS Basics, Hadoop Ecosystem Tools Overview. -Installing Hadoop. -Copying File to Hadoop. -Copy from Hadoop File system and delete file. -Moving and displaying files in HDFS. -Programming exercises on Hadoop
2	Use of Sqoop tool to transfer data between Hadoop and relational database servers. a. Sqoop - Installation. b. To execute basic commands of Hadoop ecosystem component sqoop.
3	To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands
4	Experiment on Hadoop Map-Reduce: Write a program to implement a word count program using MapReduce.
5	Experiment on Hadoop Map-Reduce: Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates,

	Joins, Sorting, Searching, etc
6	Create HIVE Database and Descriptive analytics-basic statistics.
7	Data Stream Algorithms (any one): Implementing DGIM algorithm using any Programming Language - Implement Bloom Filter using any programming language Implement Flajolet Martin algorithm using any programming language
8	Implement an iterative algorithm using Spark.
9	Create Big data analytics application dashboard using Hive and Impala
10	Design and Develop Big data application using Mllib and Spark
11	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web). -Streaming data analysis – use flume for data capture, HIVE/PYSpark for analysis of twitter data, chat data, weblog analysis etc. -Recommendation System (for example: Health Care System, Stock Market Prediction, Movie Recommendation, etc.) SpatioTemporal DataAnalytics

Useful Links	
1	https://spark.apache.org
2	https://hadoop.apahe.org
3	https://www.cloudera.com
4	http://www.mongodb.com
5	https://kafka.apache.org
AI Tools	
1	https://www.polymersearch.com/
2	https://datasquirrel.ai/
3	https://www.sisense.com/
Industry Articles	
1.	Cloudera: Driving Predictive Maintenance in a Connected World
2.	Big Data Analytics using AWS
Case Studies	
1.	https://airflow.apache.org/use-cases/
2.	https://www.sciencedirect.com/science/article/abs/pii/S0923474822000066

Term Work	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSL702and CSC702

Lab Code	Lab Name	Credit
CSDL7011	Machine Vision Lab	1

Prerequisite: C Programming Language	
Lab Objectives	
1	To perform basic image processing operations
2	To explore different preprocessing technique
3	To develop application related to Machine vision
4	To detect and recognize objects
Lab Outcomes	
1	Students will be able to read image and video file, perform different processing
2	Students will be able to do edge detection ,depth estimation
3	Students will be able to choose appropriate algo for segmentation
4	Students will be able to implement object detection technique

Suggested Experiments: Students are required to complete at least 8 experiments.	
Sr. No.	**Name of the Experiment**
1	**Handling Files, Cameras, and GUIs** Basic I/O scripts ,Reading/writing an image file, Converting between an image and raw bytes, Accessing image data with numpy.array, Reading/writing a video file Capturing camera frames, Displaying images in a window, Displaying camera frames in a window
2	**Processing Images** with OpenCV 3 Converting between different color spaces, The Fourier Transform, High pass filter, Low pass filter,
3	**Edge detection** with Canny, Contour detection, Contours – bounding box, minimum area rectangle, and minimum enclosing circle, Contours – convex contours and the Douglas-Peucker algorithm, Line and circle detection
4	**Depth Estimation** Capturing frames from a depth camera Creating a mask from a disparity map Masking a copy operation Depth estimation with a normal camera
5	**Object segmentation** using the Watershed and GrabCut algorithms Example of foreground detection with GrabCut Image segmentation with the Watershed algorithm
6	**Detecting and Recognizing Faces**

	Conceptualizing Haar cascades Getting Haar cascade data Using OpenCV to perform face detection Performing face detection on a still image
7	**Performing face detection on video** Performing face recognition Generating the data for face recognition Recognizing faces Preparing the training data Loading the data and recognizing faces Performing an Eigenfaces recognition
8	**Retrieving Images and Searching** Using Image Descriptors , Feature detection algorithms, Defining features Detecting features – corners Feature extraction and description using DoG and SIFT Anatomy of a keypoint
9	**Detecting and Recognizing Objects** Object detection and recognition techniques HOG descriptors The scale issue The location issue Non-maximum (or non-maxima) suppression Support vector machines People detection
10	**Creating and training an object detector** Bag-of-words BOW in computer vision Detecting cars in a scene

Useful Links	
1	Learning OpenCV 3 Computer Vision with Python Second Edition, by Joe Minichino Joseph Howse Published by Packt Publishing Ltd.
2	http://iitk.ac.in/ee/computer-vision-lab
3	https://nptel.ac.in/courses/108103174
4	https://docs.opencv.org/3.4/d9/df8/tutorial_root.html
AI tools	
1	https://scikit-image.org/
2	https://github.com/
3	https://opencv.org/blog/pytorch-vs-tensorflow/

Term Work	
1	Term work should consist of at least 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSDL7011 and CSDC7011

Lab Code	Lab Name	Credit
CSDL7012	Quantum Computing Lab	1

Prerequisite: Python Programming Language.	
Lab Objectives	
1	To implement fundamental quantum computing concepts
2	To learn quantum computation and quantum information
3	To understand quantum entanglement, quantum algorithms
4	To understand quantum information theory and channels
Lab Outcomes: Students will be able to	
1	Implement basic quantum computing logic by building dice and random numbers using open source simulation tools.
2	Understand quantum logic gates using open source simulation tools.
3	Implement quantum circuits using open source simulation tools.
4	I implement quantum algorithms using open source simulation tools.

Suggested Experiments: Students are required to complete at least 10 experiments.Faculty may develop their own set of experiments for students. List below is only suggestive.

Sr.No	Name of the Experiment
1	Building Quantum dice
2	Building Quantum Random No. Generation
3	Qubit Gates
4	Composing simple quantum circuits with q-gates and measuring the output into classical bits.
5	Bell Circuit & GHZ Circuit
6	Quantum Circuits
7	Implementation of Deutsch's Algorithm
8	Implementation of Deutsch-Jozsa's Algorithm
9	Implementation of Shor's Algorithms
10	Implementation of Grover's Algorithm
11	Accuracy of Quantum Phase Estimation

12	Mini Project such as implementing an API for efficient search using Grover's Algorithms or Integer factorization using Shor's Algorithm.

Useful Links	
1	IBM Experience: https://quantum-computing.ibm.com/
2	Microsoft Quantum Development Kit https://azure.microsoft.com/en-us/resources/development-kit/quantum-computing/#overview
3	Forest SDK PyQuil: https://pyquil-docs.rigetti.com/en/stable/
4	Google Quantum CIRQ https://quantumai.google/cirq
5	Qiskit Labs IBM https://learn.qiskit.org/course/ch-labs/lab-1-quantum-circuits

Term Work	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSDL7012 and CSDC7012

Lab Code	Lab Name	Credit
CSDL7013	Natural Language Processing Lab	1

Prerequisite:Java/Python	
Lab Objectives The course aims	
1	To understand the key concepts of NLP.
2	To learn various phases of NLP.
3	To design and implement various language models and POS tagging techniques
4	To understand various NLP Algorithms.
5	To learn NLP applications such as Information Extraction, Sentiment Analysis, Question answering, Machine translation etc
6	To design and implement applications based on natural language processing using LLM
Lab Outcomes	
1	Apply various text processing techniques.
2	Design a language model for word-level analysis.
3	Model linguistic phenomena with formal grammar.
4	Design, implement, and analyze NLP algorithms.
5	To apply NLP techniques to design real-world NLP applications such as machine translation, sentiment analysis, text summarization, Information extraction, Question Answering systems etc.
6	Implement a proper experimental methodology for training and evaluating empirical NLP systems using LLM

Suggested Experiments	
Sr. No.	**Name of the Experiment**
1	Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications: [Machine Translation, Text Categorization, Text summarization, chat Bot, Plagiarism, Spelling & Grammar checkers, Sentiment / opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.]
2	Apply various other text preprocessing techniques for any given text: Stop Word Removal, Lemmatization / Stemming.
3	Implement the N-Gram model for the given text input. Perform exploratory data analysis of a given text (Word Cloud)
4	Study the different POS taggers, perform POS tagging on the given text, and Perform

	Chunking for the given text input. Extract Noun Phrases, Verb Phrases, Adjective phrases, etc perform topic modeling..
5	Implement a Named Entity Recognizer for the given text input. (Domain-specific example bank, political news, tourism)
6	Implement sentiment analysis/ opinion mining for amazon product reviews.
7	Create customized prompts for customer service(product/service organization) using basic and advanced prompt engineering techniques
8	MCQ generation using Lang Chain and LLM.
9	Build a custom Chabot for documents /website using LLM
10	Implementation of mini project using LLM (preferably for regional languages) e.g. multilingual Chabot, music lyrics translator in regional language, news summarizer, chatbot assistance for ecommerce, agriculture, government , sentiment analysis of mixed case languages etc

Useful Links	
1	https://openai.com/research/
2	https://huggingface.co/
3	https://www.nltk.org/ , https://www.tensorflow.org/, https://keras.io,
4	https://github.com/stanfordnlp
5	https://promptengineering.org/
AI Tools	
1	AllenNLP https://allenai.org/allennlp/software/allennlp-library, FLAX https://github.com/google/flax,
2	https://docs.aws.amazon.com/managedservices/latest/userguide/comprehend.html
3	https://www.mindmeld.com/
Industry Articles	
1.	https://openai.com/news/
2.	https://llama.meta.com/
Case Studies	
1.	https://huggingface.co/docs/hub/en/transformers
2.	https://paperswithcode.com/task/natural-language-understanding
Datasets	
1	https://huggingface.co/datasets

2	https://www.kaggle.com/discussions/general/150720
3	https://archive.ics.uci.edu/datasets

Term Work	
1	Term work should consist of 7 experiments and Mini Project
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments+Miniproject: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSDL7013 and CSDC7013

Lab Code	Lab Name	Credit
CSDL7021	Augmented and Virtual Reality Lab	1

Prerequisite: Computer Graphics, Image Processing, Python	
Lab Objectives	
1	To perform installation of Unity
2	To explore working of VR Gadget
3	To develop scene VR application
4	To track objects in virtual environment
Lab Outcomes	
1	Setup VR development environment
2	Use HTC Vive/ Google Cardboard/ Google Daydream and Samsung gear VR.
3	Develop VR scene and place object
4	Work with Augmented Faces features.

Suggested Experiments: Students are required to complete at least 8 experiments.

Sr. No.	Name of the Experiment
1	Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
2	Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
3	Develop a scene in Unity that includes: i. a cube, plane and sphere, apply transformations on the 3 game objects. ii. add a video and audio source
4	Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects. Change the colour, material and texture of each Game object separately in the scene. Write a C# program in visual studio to change the colour and material/texture of the game objects dynamically on button click.
5	Develop a scene in Unity that includes a sphere and plane . Apply Rigid body component, material and Box collider to the game Objects. Write a C# program to grab and throw the sphere using the vr controller.
6	Develop a simple UI(User interface) menu with images, canvas, sprites and buttons. Write a C# program to interact with UI menu through VR trigger button such that on each successful trigger interaction display a score on scene
7	Place a three-dimensional ARCore pawn on detected AR plane surfaces

8	Using the Augmented Faces feature in your own apps.

Term Work	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSDL7021 and CSDC7021

Lab Code	Lab Name	Credit
CSDL7022	Blockchain Lab	1

Prerequisite: Cryptography and Network Security	
Lab Objectives	
1	To explore Blockchain concepts.
2	To implement public and private Blockchain.
3	To create applications using Blockchain.
Lab Outcomes	
1	Creating Cryptographic hash using merkle tree.
2	Design Smart Contract using Solidity.
3	Implementing ethereum blockchain using Geth.
4	Demonstrate the concept of blockchain in real world application.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Cryptography in Blockchain, Merkle root tree hash
2	Create a Blockchain using Python
3	Create a Crypto Currency using Python for the blockchain implemented experiment 2
4	Case Study on different blockchain platforms.
Identify a Domain as per your choice and perform the below experiments with respect to the selected domain	
5	Creating Smart Contract and performing transactions using Solidity and Remix IDE
6	Implement the embedding wallet and transaction using Solidity
7	Implement the Blockchain platform ethereum using Geth
8	Implement the Blockchain platform Ganache
9	Testing Interoperability and Cross-Chain Communication between platforms
10	Presentation on a suitable platform that meets the need of the Mini Project

Term Work	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSDC7022 and CSDL7022

Lab Code	Lab Name	Credit
CSDL7023	Information Retrieval Lab	1

Prerequisite	
Lab Objectives	
1	To understand the formation of queries.
2	To implement the various modeling techniques for IR.
3	To execute query expansion techniques.
4	To evaluate Information retrieval systems.
Lab Outcomes	
1	To frame queries for information retrieval
2	To implement modeling techniques
3	To perform query expansion techniques
4	To demonstrate evaluation techniques for IR

Suggested Experiments: Students are required to perform any **5 experiments** from the suggested list along with **a case study** (* indicates compulsory experiment)

Sr. No.	Name of the Experiment
1	To understand the query structure and execute various structured queries
2	To implement any IR modeling technique
3	To implement Pattern matching method used for IR
4	To execute query expansion technique (Local/Global)
5	To design inverted indices for any information retrieval model
6	To implement tf-id weighting
7	To evaluate the system/application under study
8	To understand the Case Study and generate a report for the same

Useful Links	
1	**The Noisy Channel (Daniel Tunkelang):** http://thenoisychannel.com/
2	**Search Engine Land:** https://searchengineland.com/
AI Tools	
1	**Text REtrieval Conference (TREC) Data:** https://trec.nist.gov/data.html
2	**Common Crawl:** https://commoncrawl.org/
3	**TREC Evaluation Tools:** https://trec.nist.gov/trec_eval/
4	**Apache Lucene:** https://lucene.apache.org/

Term Work	
1	Term work should consist of 5 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSDL7023 and CSDC7023

Course Code	Course Title	Credit
CSP701	Major Project 1	3

The project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions	
Course Objectives	
1	To identify and define an appropriate problem statement.
2	To perform extensive literature survey and feasibility study for the chosen problem statement.
3	To propose suitable methodology for solving the defined problem.
4	To design and implement solutions which will impact society and the environment in a positive manner.
5	To inculcate team spirit, professional, ethical behavior and leadership skills
6	To create well formatted documents using standard engineering practices
Course Outcomes	
1	Develop the understanding of the problem domain through extensive review of literature.
2	Identify and analyze the problem in detail to define its scope with problem specific data.
3	To know various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4	To design solutions for real-time problems that will positively impact society and the environment..
5	To develop clarity of presentation based on communication,teamwork and leadership skills.
6	To inculcate professional and ethical behavior.

Guidelines
1. Project topic selection and allocation

Project topic selection process to be defined and followed:

● Project orientation can be given at the end of sixth semester.
● Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
● Student's should be recommended to refer papers from reputed conferences / journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
● Students can certainly take ideas from anywhere, but be sure that they should evolve them in a unique way to suit their project requirements. Students can be informed to refer to Digital India portal, SIH portal or any other hackathon portal for problem selection.

Topics can be finalized with respect to following criterion:

● Topic Selection: The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems.
● Technology Used: Use of latest technology or modern tools can be encouraged. Students should not repeat work done previously (work done in the last three years).
● Project work must be carried out by the group of at least 3 students and maximum 4.
● The project work can be undertaken in a research institute or organization/ industry/ any business establishment (out-house projects).
● The project proposal presentations can be scheduled according to the domains and should be judged by faculty who are experts in the domain.
● Head of the department and senior staff along with project coordinators will take decisions regarding final selection of projects.
● Guide allocation should be done and students have to submit weekly progress reports to the internal guide.
● Internal guide has to keep track of the progress of the project and also has to maintain attendance reports. This progress report can be used for awarding term work marks.
● In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels.

2. Project Report Format

At the end of semester, each group needs to prepare a project report as per the guidelines issued.
A project report should preferably contain at least following details:

● Abstract
● Introduction
● Literature survey of existing system
● Limitation of existing system or research gap
● Problem statement and objectives
● Timeline Chart for Term1 and Term-II (Project Management tools can be used.)
● Proposed system
● Conceptual(block & modular diagram)
● Detailed design (DFDs, Use case, activity diagrams, etc,.)
● Methodology (your approach to solve the problem)
● Proposed Experimental Set up
● Details of Dataset
● Performance Evaluation Parameters (for Validation)
● Conclusion
● References
● Implementation Plan for Next Semester Desirable

Students can be asked to undergo Certification courses during the semester timeline (for the technical skill set that will be useful and applicable for projects.)

3.Term Work: (50)

Distribution of marks for term work shall be done based on following:
- Weekly Log Report
- Project Work Contribution
- Project Report (Spiral Bound) (both side print)
- Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

In continuous assessment focus shall also be on each individual student,assessment based on individual's contribution in group activity, their understanding and response to questions.

4. Oral and Practical

Oral and Practical examination (Final Project Evaluation) of Project 1 should be conducted by Internal and External examiners approved ,at the end of the semester.
Suggested quality evaluation parameters are as follows:
- Quality of problem selected
- Clarity of problem definition and feasibility of problem solution
- Relevance to the specialization / industrial trends
- Originality
- Clarity of objective and scope
- Quality of analysis and design
- Quality of written and oral presentation
- Individual as well as team work

Course Code	Course Title	Credit
CSC801	Distributed Computing	03

Prerequisite: Computer Networks and Operating Systems	
Course Objectives	
1	To provide students with contemporary knowledge in distributed systems.
2	To explore the various methods used for communication in distributed systems
3	To provide skills to measure the performance of distributed synchronization algorithms.
4	To provide knowledge of resource management, and process management including process migration
5	To learn issues involved in replication, consistency, and file management
6	To learn the concept of a distributed file system and middleware technologies
Course Outcomes	
1	Demonstrate knowledge of the basic elements and concepts related to distributed system technologies
2	Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware.
3	Analyze the various techniques used for clock synchronization, mutual exclusion and deadlock.
4	Demonstrate the concepts of Resource and Process management
5	Demonstrate the concepts of Consistency, Replication Management and fault Tolerance.
6	Apply the knowledge of Distributed File systems and middleware technologies

Module	Content		Hours
1	**Introduction to Distributed Systems**		**04**
	1.1	Characterization of Distributed Systems: Issues, Goals, and Types of distributed systems, Hardware and Software Concepts: NOS, DOS, Middleware	
2	**Communication**		**04**
	2.1	Interprocess communication (IPC): Remote Procedure Call (RPC), RPC Models: Call Semantics, Server Semantics, Lightweight RPC, Callback RPC, Remote Method Invocation (RMI)	
	2.2	Message-Oriented Communication, Multicast Communication, Group Communication	
3	**Synchronization**		

	3.1	Clock Synchronization: Physical clock, Logical Clocks(scalar & vector), Election Algorithm	
	3.2	Distributed Mutual Exclusion, Requirements of Mutual Exclusion Algorithms and Performance measures. Non- token Based Algorithms: Lamport, Ricart–Agrawala's and Maekawa's Algorithms; Token-based Algorithms: Suzuki-Kasami's Broadcast Algorithms and Raymond's Tree-based Algorithm; and Comparative Performance Analysis	
4	**Resource and Process Management**		**07**
	4.1	Introduction to Code Migration., Bindings, Process Migration and its types	
	4.2	Desirable Features of Global Scheduling algorithm, Task assignment Approach, Load balancing approach and load sharing approach	
	4.3	Deadlock detection in distributed systems: Introduction – Concept of Cycle and Knot, System model, Models of deadlocks (AND Model, Or Model), Chandy–Misra–Haas algorithm	
5	**Replication, Consistency and Fault Tolerance**		**08**
	5.1	Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models	
	5.2	Fault Tolerance: Introduction, Design Issues, Failure Masking and Replication, Failure Detection, Recovery.	
6	**Current Trends and Case studies**		**06**
	6.1	Introduction and features of DFS, File models, File Accessing models, File Caching Schemes, File Replication, File System Performance and Scalability	
	6.2	Case Studies of Distributed File Systems ,Hadoop HDFS, Google File System, Apache Cassandra File System (CFS),Amazon S3 etc.	
		Total	**39**

Textbooks	
1	Andrew S. Tanenbaum and Maarten Van Steen, Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2	Mukesh Singhal, Niranjan G. Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems", MC Graw Hill education
3	Pradeep K.Sinha, "Distributed Operating System-Concepts and design", PHI.
References	
1	M. L. Liu, ―Distributed Computing Principles and Applications‖, Pearson Addison Wesley, 2004

Textbooks	
2	George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005
Useful Links	
1	https://nptel.ac.in/courses/106106107
2	https://nptel.ac.in/courses/106106168
3	http://csis.pace.edu/~marchese/CS865/Lectures/Chap7/Chapter7fin.htm
4	https://nptel.ac.in/courses/106104182
AI Tools	
1.	https://www.dask.org/
2.	https://airflow.apache.org/
3.	https://grpc.io/
4.	https://www.baeldung.com/cs/consensus-algorithms-distributed-systems
Case Studies	
1	**Google File System**
2.	**Cassendra File System**
3.	**Apache Zookeeper**

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5
2	Literature review of papers/journals	5
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5
4	Wins in the event/competition/hackathon pertaining to the course	10

5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10
11	Peer Review and participation	5/10
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

Course Code	Course Title	Credit
CSDC8011	Deep Learning	3

Prerequisite: Basic mathematics and Statistical concepts, Linear Algebra, Machine Learning	
Course Objectives	
1	To learn the fundamentals of Neural networks.
2	To gain an in-depth understanding of training Deep Neural Networks.
3	To acquire knowledge of advanced concepts of Convolution Neural Networks, Autoencoders, and Recurrent Neural Networks.
4	Students should be familiar with the recent trends in Deep Learning
Course Outcomes	
1	Gain basic knowledge of Neural Networks.
2	Acquire an in-depth understanding of training Deep Neural Networks.
3	Design appropriate DNN model for supervised applications.
4	Design appropriate DNN model for unsupervised applications.
5	Design appropriate DNN models for sequence learning applications.
6	Gain familiarity with recent trends and applications of Deep Learning.

Module		Content	Hours
1		**Fundamentals of Neural Network**	**04**
	1.1	Biological neuron, Mc-Culloch Pitts Neuron, Perceptron, Perceptron Learning, Delta learning, Multilayer Perceptron	
	1.2	Linearly separable, linearly non-separable classes, Deep Networks: Fundamentals, Brief History, Three Classes of Deep Learning Basic Terminologies of Deep Learning,	
2		**Training, Optimization and Regularization of Deep Neural Network**	**10**
	2.1	Training Feedforward DNN Multi-Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function	
	2.2	Optimization**:** Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp	

	2.3	Regularization**:** Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output,	
3	**Autoencoders: Unsupervised Learning**		**05**
	3.1	Introduction, Linear Autoencoder, Under complete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders	
	3.2	Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders	
	3.3	Application of Autoencoders: Image Compression	
4	**Convolutional Neural Networks (CNN): Supervised Learning**		**06**
	4.1	Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function	
	4.2	Modern Deep Learning Architectures: LeNET: Architecture, AlexNET: Architecture	
5	**Recurrent Neural Networks (RNN):**		**08**
	5.1	Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNNBackpropagation Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT	
	5.2	Long Short-Term Memory: Selective Read, Selective write, Selective Forget, Gated Recurrent Unit	
6	**Recent Trends and Applications:**		**06**
	6.1	Transfer Learning, Customize a pre-trained model: Feature Extraction, Fine-Tuning, Transfer Learning Implementation using VGG16 Model/ MobileNetV2/YO LO/GloVe/ ResNet50	
	6.2	Generative Adversarial Network (GAN): Architecture, Applications: Image Generation, DeepFake, ChatGPT	
		Total	**39**

Textbooks	
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville. ―Deep Learning‖, MIT Press Ltd, 2016
2	Li Deng and Dong Yu, ―Deep Learning Methods and Applications‖, Publishers Inc.
3	Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.

4	JM Zurada —Introduction to Artificial Neural Systems‖, Jaico Publishing House
5	M. J. Kochenderfer, Tim A. Wheeler. —Algorithms for Optimization‖, MIt Press..
References	
1	Buduma, N. and Locascio, N., —Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc.".
2	François Chollet. —Deep learning with Python —(Vol. 361). 2018 New York: Manning.
3	Douwe Osinga. —Deep Learning Cookbook‖, O'REILLY, SPD Publishers, Delhi.
4	Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc
5	Charu.C.Aggarwal, "Neural Networks and Deep Learning", Springer, 1st Edition
6	S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India
Useful Links	
1	https://nptel.ac.in/courses/106/106/106106184/
2	https://www.deeplearningbook.org/
3	https://www.coursera.org/specializations/deep-learning, https://course.fast.ai/
AI tools	
1	ConvNet Playground(https://github.com/fastforwardlabs/convnetplayground)
2	CNN (https://poloclub.github.io/cnn-explainer/)
3	GAN (https://poloclub.github.io/ganlab/)
4	https://h2o.ai/
5	https://ieeexplore.ieee.org/document/8624570
6	https://ieeexplore.ieee.org/document/9382625
7	https://github.com/openai/gym
Industry articles	
1	Art Generation(https://www.ipic.ai/, divi-ai.com)

2	https://www.mdpi.com/2073-8994/15/2/535
3	Time series forecasting (https://www.influxdata.com/time-series-forecasting-methods)
4	Neo4j's integration with deep learning(https://arxiv.org/abs/2304.00192)
Case studies	
1	https://rb.gy/op0l7v
2	https://developer.ibm.com/technologies/deep-learning/articles/
3	https://slejournal.springeropen.com/articles/10.1186/s40561-022-00192-z

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5
2	Literature review of papers/journals	5
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5
4	Wins in the event/competition/hackathon pertaining to the course	10
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
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Indirect Assessment	
1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture
End Semester Theory Examination	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Course Title	Credit
CSDC8012	Digital Forensics	3

Prerequisite	
Course Objectives	
1	To discuss the need and process of digital forensics and Incident Response Methodology.
2	To explore the procedures for identification, preservation, and acquisition of digital evidence.
3	To explore techniques and tools used in digital forensics for Operating system and malware investigation
4	To explore techniques and tools used for Mobile forensics and browser, email forensics
Course Outcomes	
1	Discuss the phases of Digital Forensics and methodology to handle the computer security incident.
2	Describe the process of collection, analysis and recovery of the digital evidence.
3	Explore various tools to analyze malwares and acquired images of RAM/hard drive
4	Acquire adequate perspectives of digital forensic investigation in mobile devices
5	Analyze the source and content authentication of emails and browsers
6	Produce unambiguous investigation reports which offer valid conclusions.

Module	Content		Hours
1	**Introduction to Digital Forensics**		06
	1.1	Digital Forensics Definition, Digital Forensics Goals, Digital Forensics Categories - Computer Forensics, Mobile Forensics, Network Forensics, Database Forensics	
	1.2	Introduction to Incident - Computer Security Incident, Goals of Incident Response, CSIRT, Incident Response Methodology, Phase after detection of an incident	
2	**Digital Evidence, Forensics Duplication and Digital Evidence Acquisition**		09
	2.1	Digital evidence, Types of Digital Evidence, Challenges in acquiring Digital evidence, Admissibility of evidence, Challenges in evidence handling, Chain of Custody	
	2.2	Digital Forensics Examination Process - Seizure, Acquisition, Analysis, Reporting. Necessity of forensic duplication, Forensic image formats, Forensic duplication techniques,.	

	2.3	Acquiring Digital Evidence - Forensic Image File Format, Acquiring Volatile Memory (Live Acquisition), Acquiring Nonvolatile Memory (Static Acquisition), Hard Drive Imaging Risks and Challenges, Network Acquisition	
3	**Forensics Investigation**		**04**
	3.1	Analyzing Hard Drive Forensic Images, Analyzing RAM Forensic Image, Investigating Routers	
	3.2	Malware Analysis - Malware, Viruses, Worms, Essential skills and tools for Malware Analysis, List of Malware Analysis Tools and Techniques	
4	**Windows and Unix Forensics Investigation**		**08**
	4.1	Investigating Windows Systems - File Recovery, Windows Recycle Bin Forensics, Data Carving, Windows Registry Analysis, USB Device Forensics, File Format Identification, Windows Features Forensics Analysis, Windows 10 Forensics, Cortana Forensics	
	4.2	Investigating Unix Systems - Reviewing Pertinent Logs, Performing Keyword Searches, Reviewing Relevant Files, Identifying Unauthorized User Accounts or Groups, Identifying Rogue Processes, Checking for Unauthorized Access Points, Analyzing Trust Relationships	
5	**Mobile Forensics**		**08**
	5.1	Android Forensics, Mobile Device Forensic Investigation - Storage location, Acquisition methods, Data Analysis	
	5.2	GPS forensics - GPS Evidentiary data, GPS Exchange Format (GPX), GPX Files, Extraction of Waypoints and TrackPoints, Display the Tracks on a Map.	
	5.3	SIM Cards Forensics - The Subscriber Identification Module (SIM), SIM Architecture, Security, Evidence Extraction.	
6	**Browser, Email Forensic & Forensic Investigation Reporting**		**04**
	6.1	Web Browser Forensics, Google chrome, Other web browser investigation Email forensics - Sender Policy Framework (SPF), Domain Key Identified Mail (DKIM), Domain based Message Authentication Reporting and Confirmation (DMARC)	
	6.2	Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report	
		Total	**39**

Textbooks	
1	Kevin Mandia, Chris Prosise, ―Incident Response and computer forensics‖, Tata McGrawHill, 2006

Textbooks	
2	Digital Forensics Basics A Practical Guide Using Windows OS — Nihad A. Hassan, APress Publication, 2019
3	Xiaodong Lin, ―Introductory Computer Forensics: A Hands-on Practical Approach‖, Springer Nature, 2018
Useful Links	
1	Course on ―Ethical Hacking‖ https://nptel.ac.in/courses/106/105/106105217/
2	Course on ―Digital Forensics‖ https://onlinecourses.swayam2.ac.in/cec20_lb06/preview
3	Course on Cyber Incident Response https://www.coursera.org/learn/incident-response
4	Course on ―Penetration Testing, Incident Responses and Forensics‖ https://www.coursera.org/learn/ibm-penetration-testing-incident-response-forensics

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5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10

10	Mini Project / Extra Experiments/ Virtual Lab	10
11	GATE Based Assignment test/Tutorials etc	10
12	Peer Review and participation	5/10
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

Course Code:	Course Title	Credit
CSDC8013	Applied Data Science	3

Prerequisite: Engineering Mathematics, Machine Learning, Data Structures & Algorithms	
Course Objectives	
1	To introduce students to the basic concepts of data science.
2	To acquire an in-depth understanding of data exploration and data visualization.
3	To be familiar with various anomaly detection techniques.
4	To understand the data science techniques for different applications.
Course Outcomes	
1	To gain fundamental knowledge of the data science process.
2	Apply different methodologies and evaluation strategies.
3	To apply data exploration and visualization techniques
4	To apply anomaly detection techniques.
5	To gain an in-depth understanding of time-series forecasting.
6	To apply Optimization Techniques and explore data science techniques to real world applications.

Module	Content		Hours
1	**Introduction to Data Science**		**05**
	1.1	Introduction to Data Science, Data Science Process	
	1.2	Motivation to use Data Science Techniques: Volume, Dimensions and Complexity, Data Science Tasks and Examples	
	1.3	Overview of Data Preparation, Modeling, Difference between data science and data analytics	
2	**Data Exploration**		**10**
	2.1	Descriptive Statistics: Univariate Exploration: Measure of Central Tendency(Methods to calculate Arithmetic Mean,Weighted Mean,Median,Mode) Measure of Dispersion(Range,Quartile Deviation,IQR),Measures of Skewness (Karl Pearson Coeff.of skewness, Bowley's Coefficient of skewness), Measures of Kurtosis Multivariate Exploration:Correlation Analysis, Concept of Correlation,Bivariate Distribution,Covariance Types of correlation, Karl Pearson's Coefficient of Correlation	
	2.2	Inferential Statistics: Overview of Various forms of distributions: Normal, Poisson	

		Statistical Inference-Tests of Significance: Procedure for testing a Hypothesis,Significance tests in Attributes,Test of significance of a single Mean, Central limit theorem, Confidence Interval, Z-test, t-test, Type-I, Type-II Errors, F-Distribution and Analysis of Variance(ANOVA)	
3	**Methodology and Data Visualization**		**06**
	3.1	Methodology: Overview of model building, Cross Validation, K-fold cross validation, leave-1 out, Bootstrapping	
	3.2	Data Visualization Univariate Visualization: Histogram, Quartile, Distribution Chart Multivariate Visualization: Scatter Plot, Scatter Matrix, Bubble chart, Density Chart, Roadmap for Data Exploration	
		Self-Learning Topics: Visualizing high dimensional data: Parallel chart, Deviation chart, Andrews Curves.	
4	**Anomaly Detection**		**06**
	4.1	Outliers, Causes of Outliers, Anomaly detection techniques, Outlier Detection using Statistics	
	4.2	Outlier Detection using Distance based method, Outlier detection using density-based methods, SMOTE	
5	**Time Series Forecasting**		**08**
	5.1	Taxonomy of Time Series Forecasting methods, Time Series Decomposition	
	5.2	Smoothening Methods: Average method, Moving Average smoothing, Time series analysis using linear regression, ARIMA Model, Performance Evaluation: Mean Absolute Error, Root Mean Square Error, Mean Absolute Percentage Error, Mean Absolute Scaled Error	
	5.3	Self Learning Topics**:** Evaluation parameters for Classification, regression and clustering.	
6	**Optimization Techniques and Applications of Data Science**		**04**
	6.1	Optimization: Global and local optima; Unconstrained and constrained optimization; Introduction to least-squares optimization	
	6.2	Predictive Modeling: House price prediction, Fraud Detection Clustering: Customer Segmentation,Use cases for Health care, Time series forecasting: Weather Forecasting, Recommendation engines: Product recommendation	
		Total	**39**

Textbooks	
1	Vijay Kotu, Bala Deshpande. "Data Science Concepts and Practice", Elsevier, M.K. Publishers.
2	Steven Skiena, "Data Science Design Manual", Springer International Publishing AG
3	Samir Madhavan. "Mastering Python for Data Science", PACKT Publishing
4	Dr. P. N. Arora, Sumeet Arora, S. Arora, Ameet Arora, "Comprehensive Statistical Methods", S.Chand Publications, New Delhi.

References	
1	Jake VanderPlas. "Python Data Science Handbook", O'reilly Publications.
2	Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor, "Recommender Systems Handbook", Springer.
3	S.C. Gupta, V. K. Kapoor "Fundamentals of Mathematical Statistics", S. Chand and Sons, New Delhi.
4	B .L .Agrawal. "Basic Statistics", New Age Publications, Delhi.
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2	https://onlinecourses.nptel.ac.in/noc21_cs69/preview
3	https://www.coursera.org/specializations/applied-data-science
4	www.IntroDataScience.com.
5	https://rapidminer.com/
6	https://julialang.org/
7	https://towardsdatascience.com/machine-learning/home
AI Tools	
1	https://h2o.ai/
2	https://datasquirrel.ai/
3	https://flourish.studio/
Case Studies	
1	https://www.analyticsvidhya.com/blog/2021/05/data-science-in-healthcare/
2	https://neptune.ai/blog
3	https://towardsdatascience.com/
Datasets	
1	https://www.kaggle.com/datasets
2	https://archive.ics.uci.edu/
3	https://data.gov/

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5
2	Literature review of papers/journals	5
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5
4	Wins in the event/competition/hackathon pertaining to the course	10
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10
11	Peer Review and participation	5/10

*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

Indirect Assessment

1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture

End Semester Theory Examination

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Course Title	Credit
CSDC8021	Optimization in Machine learning	3

Prerequisite: Engineering Mathematics, Algorithms and data structures	
Course Objectives	
1	Understand, analyze and apply existing derivative based optimization algorithms
2	Analyze and apply stochastic methods in optimization
3	Analyze convex optimization for machine learning problems
4	Understand real life problems and apply evolutionary methods to optimize them
Course Outcomes	
1	To apply foundational optimization ideas
2	To understand first order optimization methods
3	To compare various stochastic methods of optimization
4	To apply convex optimization algorithm
5	To analyze and demonstrate several population methods in Evolutionary Computation
6	To apply advanced evolutionary algorithms such as particle swarm and ant colony optimization

Module	Content		Hours
1	**Introduction and Background to Optimization Theory**		**04**
	1.1	Basic Ingredients of Optimization Problems, Optimization Problem Classifications, Optima Types, Optimization Method Classes, Overview of Unconstrained and Constrained Optimization, Basics of convex optimization	
2	**Derivative based Optimization**		**10**
	2.1	The Basics of Optimization (univariate, bivariate and multivariate optimization), Convex Objective Functions	
	2.2	First-Order optimization Methods : Gradient Descent, Conjugate Gradient, Momentum, Nesterov Momentum, Adagrad, RMSProp, learning rate optimization	
	2.3	Second order optimization: Newton method	

3	**Stochastic Methods**		**06**
	3.1	Noisy Descent, Mesh Adaptive Direct Search, Cross-Entropy Method, Natural Evolution Strategies, Covariance Matrix Adaptation	
4	**Convex Optimization**		**06**
	4.1	Optimization problems, Convex optimization, Linear optimization problems, Quadratic optimization problems, Geometric programming, Overview of Generalized inequality constraints and Vector optimization	
5	**Evolutionary Methods**		**08**
	5.1	Introduction to Evolutionary Computation: Generic Evolutionary Algorithm, Representation: The Chromosome, Initial Population, Fitness Function, Selection: Selective Pressure, Random Selection, Proportional Selection, Tournament Selection, Rank-Based Selection, Elitism and Evolutionary Computation versus Classical Optimization, Stopping conditions	
	5.2	Canonical Genetic Algorithm, Binary Representations of Crossover and Mutation: Binary Representations, Control Parameters	
6	**Advance Evolutionary Methods**		**05**
	6.1	Basic Particle Swarm Optimization, Global Best PSO, Local Best PSO, g-best versus l-best PSO, Velocity Components, Geometric Illustration, Algorithm Aspects, Social Network Structures	
	6.2	Ant Colony Optimization Meta-Heuristic, Foraging Behavior of Ants, Stigmergy and Artificial Pheromone, Simple Ant Colony Optimization, Ant System, Ant Colony System	
		Total	**39**

Textbooks	
1	Algorithms for Optimization, Mykel J. Kochenderfer, Tim A.Wheeler, The MIT Press (2019)
2	Computational Intelligence-An Introduction, Andries P Engelbrecht, Second-Edition, Wiley publication
3	Linear Algebra and Optimization for Machine Learning, Charu C. Aggarwal, A Textbook, Springer (2020)
References	
1	Convex Optimization, Stephen Boyd, Department of Electrical Engineering, Stanford University and Lieven Vandenberghe, Electrical Engineering Department, University of California, Los Angeles, Cambridge University Press
2	Genetic Algorithms in Search, optimization and machine learning, David D Goldberg, Addison Wesley
3	Optimization for Machine Learning, Suvrit Sra, Sebastian Nowozin, Stephen J. Wright, - The MIT Press
4	Optimization techniques and applications with examples, Xin-She Yang Middlesex University London, Wiley
5	Introduction to Evolutionary Computing, A.E. Eiben, J. E. Smith, Springer
Useful links	
1	https://onlinecourses.nptel.ac.in/noc23_cs64/preview
2	https://optml.mit.edu/teach/6881/
3	https://edu.epfl.ch/coursebook/en/optimization-for-machine-learning-CS-439
4	https://github.com/epfml/OptML_course/tree/master/lecture_notes
White papers	
1	https://rb.gy/7taecr
2	https://arxiv.org/pdf/1906.06821
3	https://rb.gy/afus31

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5
2	Literature review of papers/journals	5
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5
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8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10
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Indirect Assessment

1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture

End Semester Theory Examination

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Course Title	Credit
CSDC8022	High Performance Computing	3

Prerequisite: Computer Architecture, Operating System, Cloud Computing	
Course Objectives	
1	Introduce the fundamental concepts of high-performance computing (HPC) architecture and parallel computing
2	Provide foundations for developing, analyzing, and implementing parallel algorithms using parallelization paradigms like MPI, OpenMP, OpenCL, and CUDA.
3	Introduce range of activities associated with HPC in Cloud
Course Outcomes	
1	Understand parallel and pipeline processing approaches
2	Design a parallel algorithm to solve computational problems and identify issues in parallel programming.
3	Analyze the performance of parallel computing systems for clusters in terms of execution time, total parallel overhead, speedup.
4	Develop efficient and high-performance parallel algorithms using OpenMP and message passing paradigm
5	Develop high-performance parallel programming using CUDA framework
6	Perform the range of activities associated with High Performance Computing in CloudComputing

Module		Content	Hours
1	**Introduction to Parallel Computing**		**05**
	1.1	Parallelism (What, Why, Applications), Levels of parallelism (instruction, transaction, task, thread, memory, function)	
	1.2	Classification Models: Architectural Schemes (Flynn's, Shore's, Feng's, Handler's)	
	1.3	Memory Access: Distributed Memory, Shared Memory, Hybrid DistributedShared Memory	
	1.4	Parallel Architecture: Pipeline Architecture: Arithmetic pipelines, Floating Point, Array Processor	
2	**Parallel Programming Platform and Algorithm Design**		**10**
	2.1	Parallel Programming Platform: Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines	

	2.2	Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.	
3	**Performance Measures**		**04**
		Performance Measures: Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Folk Theorem, Amdahl's Law, Gustafson's Law, Performance Bottlenecks, The Karp Flatt Metric.	
4	**Message Passing**		**05**
		Principles of Message Passing Programming, The Building Blocks Operations, Message Passing Interface, Topology and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations	
5	**HPC Programming: OpenMP and MPI**		**10**
		Thread Basics, The POSIX Thread API, Thread Basics Thread Synchronization, Attributes, Thread Cancellation, Composite Synchronization Constructs. Share memory Architecture, Multi-core processors and Hyperthreading, Fork and join model. OpenMP directives, Processes, Multiprocessor programming model, Distributed system programming model, Inter-process communication using message passing: Asynchronous and Synchronous, MPI Programming, Message passing vs Share memory communication: Advantages and disadvantage	
6	**Parallel programming using accelerators and recent trends**		**05**
	6.1	An Overview of GPGPUs, Introduction to CUDA, Introduction to Heterogeneous Computing using OpenCL, An Overview of OpenCL API, Heterogeneous Programming in OpenCL.	
	6.2	Virtualization and Containerization, HPC in the Cloud Use Cases.	
		Total	**39**

Textbooks	
1	AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar —Introduction to Parallel Computing‖, 2nd edition, Addison Wesley, 2003.
2	Shane Cook, Morgan Kaufmann —CUDA Programming: A Developer's Guide to Parallel Computing with GPUs, 2012.
3	M. R. Bhujade —Parallel Computing‖,2nd edition, New Age International Publishers, 2009.
4	Kai Hwang, Naresh Jotwani, —Advanced Computer Architecture: Parallelism, Scalability, Programmability McGraw Hill, Second Edition, 2010.
5	Georg Hager, Gerhard Wellein, Chapman —Introduction to High Performance Computing for Scientists and Engineers Hall/CRC Computational Science Series, 2011.
References	
1	Michael J. Quinn —Parallel Programming in C with MPI and OpenMPI‖ by, McGraw Hill Education, 2008.
2	Kai Hwang, Zhiwei, Scalable Parallel ComputingTechnology, Architecture,Programming‖, McGraw-Hill Education, 1998.
3	Laurence T. Yang, Minyi Guo, —High-Performance Computing: Paradigm and Infrastructure‖, by, Wiley, 2006.
Useful Links	
1	https://nptel.ac.in/courses/112105293
2	https://archive.nptel.ac.in/courses/128/106/128106014/

Internal Assessment
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Continuous Assessment
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5
2	Literature review of papers/journals	5
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5

4	Wins in the event/competition/hackathon pertaining to the course	10
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
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7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
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Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination		
1	Question paper will be of 60 marks	
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Course Code	Course Title	Credit
CSDC8023	Social Media Analytics	03

Prerequisite: Graph Theory, Data Mining, Python programming	
Course Objectives	
1	Familiarize the learners with the concept of social media
2	Familiarize the learners with the concept of social media analytics and understand its significance
3	Enable the learners to develop skills required for analyzing the effectiveness of social media
4	Familiarize the learners with different tools of social media analytics.
5	Familiarize the learner with different visualization techniques for Social mediaanalytics
6	Familiarize the ethical and legal implications of leveraging social media analytics for business intelligence
Course Outcomes	
1	Understand the concept of Social media
2	Understand the concept of social media Analytics and its significance
3	Learners will be able to analyze the effectiveness of social media
4	Learners will be able to use different Social media analytics tools effectively and efficiently.
5	Learners will be able to use different effective Visualization techniques to represent social media analytics.
6	Acquire the fundamental perspectives, hands-on skills, and ethical knowledge to responsibly leverage social media data for informed business decision-making,

Module	Content	Hours
1	**Social Media Analytics: An Overview** Core Characteristics of Social Media, Types of Social Media, Social media landscape, Need for Social Media Analytics (SMA), SMA in small & large organizations. Purpose of Social Media Analytics, Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools	06
2	**Social Network Structure, Measures & Visualization**	06

	Basics of Social Network Structure - Nodes, Edges & Tie Describing the Networks Measures - Degree Distribution, Density, Connectivity, Centralization, Tie Strength & Trust Network Visualization - Graph Layout, Visualizing Network features, Scale Issues. Social Media Network Analytics - Common Network Terms, Common Social Media Network Types, Types of Networks, Common Network Terminologies, Network Analytics Tools.Clustering of Social network graphs, direct discovery of communities in a social graph , Clique Perculaton Algorithm	
3	**Social Media Text, Action & Hyperlink Analytics** Social Media Text Analytics - Types of Social Media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text Analysis ToolsSocial Media Action Analytics - What Is Actions Analytics? Common Social Media Actions, Actions Analytics Tools Social Media Hyperlink Analytics - Types of Hyperlinks, Types of Hyperlink Analytics, Hyperlink Analytics Tools	**08**
4	**Social Media Location & Search Engine Analytics** Location Analytics - Sources of Location Data, Categories of Location Analytics, Location Analytics and Privacy Concerns, Location Analytics Tools Search Engine Analytics - Types of Search Engines, Search Engine Analytics, Search Engine Analytics Tools, Page Rank algorithm, HITS algorithm for page rank	**06**
5	**Social Information Filtering** Social Information Filtering - Social Sharing and filtering , Automated Recommendation systems, Design of Traditional Vs social Recommendation Systems Understanding Social Media and Business Alignment, Social Media KPI, Formulating a Social Media Strategy, Managing Social Media Risks	**06**
6	**Digital Marketing ,Social Media Analytics Applications and Privacy** Social media applications in public and private sector, Digital Marketing, Digital marketing and its significance in today's business landscape,Predictive Analytics in Digital Marketing Privacy - Privacy policies, data ownership and maintaining privacy online.	**06**
	Total	**39**

Textbooks	
1	Seven Layers of Social Media Analytics_ Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data, Gohar F. Khan,(ISBN-10: 1507823207)
2	Analyzing the Social Web 1st Edition by Jennifer Golbeck
3	Mining the Social Web_ Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites, Matthew A Russell, O'Reilly

Textbooks	
4	Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die 2nd Edition, Kindle Editionby Eric Siegel (Author)
References	
1	Social Media Analytics [2015], Techniques and Insights for Extracting Business ValueOut of Social Media, Matthew Ganis, AvinashKohirkar, IBM Press
2	Social Media Analytics Strategy_ Using Data to Optimize Business Performance, Alex Gonçalves, APress Business Team
3	Social Media Data Mining and Analytics, Szabo, G., G. Polatkan, O. Boykin & A. Chalkiopoulus (2019), Wiley, ISBN 978-1-118-82485-6
Useful Links	
1	https://cse.iitkgp.ac.in/~pawang/courses/SC16.html
2	https://onlinecourses.nptel.ac.in/noc20_cs78/preview
3	https://nptel.ac.in/courses/106106146
4	https://7layersanalytics.com/
AI Tools	
1	https://www.brandwatch.com/
2	https://sproutsocial.com/
3	https://www.socialbakers.com/
4	https://hootsuite.com/platform/insights
Case Studies	
1	https://ideas.repec.org/a/aag/wpaper/v25y2021i2p51-73.html
2	https://barnraisersllc.com/2015/11/23/7-case-studies-show-social-media-analytics-pay-off/

Internal Assessment:
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Continuous Assessment:

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Indirect Assessment	
1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture

End Semester Theory Examination:	
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3	All questions have equal weightage and carry 20 marks each
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Course Code	Course Title	Credit
ILO8021	Project Management	3

Prerequisite: Software Engineering and its concepts.	
Course Objectives	
1	To familiarize the students with the use of a structured methodology/approach for each and every unique project
2	Awareness about the utilizing project management concepts, tools and techniques in managing the Project
3	To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure
4	Focus on Planning and Risk management techniques in the development of a Project
5	Effective Techniques for Monitoring and Control of the Projects.
6	Awareness about the ethics to be followed in a project and quality of leadership.
Course Outcomes	
1	To understand the Necessity of Project management and Project Management Knowledge Areas.
2	Apply selection criteria and select an appropriate project from different options.
3	Perform SWOT Analysis and Prepare a Work Breakdown Structure for a project and develop a schedule based on it.
4	Identify the Risk and solution to it
5	To understand Project Monitoring and Control using various Techniques
6	Project Management towards Effective Leadership and Quality of the project.

Module	Content		Hours
1	**Project Management Foundation:**		**06**
		Definition of a project, Project v/s Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and Role of project manager. Different Forms of Project Management, Project Environment, Project Management for Industry, Service Sector and Public Sector. Negotiations and resolving conflicts. PM knowledge areas as per Project Management Institute (PMI).	
2	**Initiating Projects:**		**06**
		How to get a project started, Selecting projects strategically, Project selection models (Numeric /Scoring Models and Non-numeric	

		models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	
3	**Software Project Planning & Software Cost Estimation:**		**08**
		Business Case, Project selection and Approval, Project charter, Project Scope management, Creating the Work Breakdown Structures (WBS). Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS). Software Estimation: Size Estimation: Function Point (Numericals). Cost Estimation: COCOMO (Numericals), COCOMO-II (Numericals) till Early design model.	
4	**Planning Projects:**		**07**
		Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Software Risk Management: Identify IT Project Risk, Risk Analysis and Assessment, Risk Strategies, Risk Monitoring and Control, Risk Response and Evaluation.	
5	**Monitoring and Controlling Projects:**		**06**
		Project Organization, Agile Project Management and Team Building, Earned Value Management techniques for measuring value of work completed; Change Management. Project Contracting : Project procurement management, contracting and outsourcing	
6	**Project Leadership and Ethics:**		**06**
		Introduction to project leadership, ethics in projects. Multicultural and virtual projects. Project Quality Management**:** Concept of Quality, Process of Quality Management , Quality Assurance Techniques Closing the Project: Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures;	
		Total	**39**

Textbooks	
1	Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd
2	Gido Clements, Project Management, Cengage Learning.
3	Gopalan, Project Management, , WileyIndia
4	John M Nicholas, Herman Steyn , Project Management for Engineering, Business and Technology, Routledge, Taylor Francis Group.
Reference Books	
1	Dennis Lock, Project Management, Gower Publishing England, 9 thEd.
2	Managing Information Technology Project, 6th Edition, by Kathy Schwalbe, Cengage Learning publication
Resources	
1	Guide to PMBOK Text Book
2	Project Management (Managerial Approach) Text Book.
3	Project Mangement PPT
4	Project Initiation phase PPT
5	Project Management (Introduction)
6	Project Team
White Papers	
1	Revamping The Project management
2	How Agile are Companies in Germany
3	Agile Management (NOT) a Contradiction
Case Studies	
1	https://www.pmi.org/business-solutions/case-studies
2	https://www.pmsolutions.com/case-studies
3	PM Case Studies with Examples

Internal Assessment		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment		
Sr. No	**Rubrics**	**Marks**
1	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10
2	Activity on Design Thinking and Agile Methodology	10
3	Content beyond syllabus presentation	10
5	Extra Assignment / Case Studies Assignment	10
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5
8	Multiple Choice Questions (Quiz)	5
9	Preparation of project Template on any 2 of the Project Templated suggested by PMI	10
10	Participation and Peer Review on Project Management Methodologies	10
11	Interview of the person working as a Project Manager in IT Industry or a service Industry (Person should have Relevant PM expertise)	10
12	Representation of a Technical Paper based on Project Management in UGC Care/ SCI / IEEE / Book Chapter in the Journal approved by Subject Teacher as a Author and Co-Author	10
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

Course Code:	Course Title	Credit
ILO 8022	Finance Management	3

Prerequisite:	
Course Objectives	
1	To know about the Indian financial system, instruments and market.
2	To understand the relationship between risk, return and time value of Money.
3	To understand the financial statements and ratio analysis.
4	To understand capital budgeting and working capital management.
5	To know about Capital structure and its approaches.
6	To understand different dividend policy theories.
Course Outcomes	
1	To explain Indian financial system , instrument and market
2	To determine risk, return and time value of Money with respect to financial decisions.
3	To decide investment decisions for projects with the help of financial ratios.
4	To explain capital budgeting structure and working capital management.
5	To discuss the concept of capital structure and its approaches.
6	To apply dividend policies with respect to various scenarios.

Module	Content		Hours
1	**Indian Financial System**		**08**
	1.1	Characteristics, Components and Functions of Financial System. Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares,Bonds-Debentures, Certificates of Deposit, Treasury Bills, Trade credit.	
	1.2	Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and ForeignCurrency Market	
	1.3	Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	
2	**Financial Risk and Returns**		**06**

	2.1	Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio	
	2.2	Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio	
	2.3	Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting	
3	**Corporate Finance**		**09**
	3.1	Overview of Corporate Finance: Objectives of Corporate Finance;Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision	
	3.2	Overview of Financial Statements,Balance Sheet, Profit and Loss Account, and Cash Flow Statement.	
	3.3	Financial Ratio Analysis: Purpose of Financial Ratio Analysis.Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
4	**Capital Budgeting**		**10**
	4.1	Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions	
	4.2	Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV),Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)	
	4.3	Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements, Management of Inventories; Management of Receivables, and Management of Cash and Marketable Securities	
5	**Capital Structure**		**03**
	5.1	Factors Affecting an Entity's Capital Structure, Overview of Capital Structure Theories	
	5.2	Capital Structure Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
6	**Dividend Policy**		**03**
	6.1	Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach and Modigliani Miller Approach	
		Total	**39**

Reference Books	
1	Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2	Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi
3	Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4	Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L)& Company Limited, New Delhi.

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10
2.	Wins in the event/competition/hackathon	10
3.	Content beyond syllabus presentation	10
4.	Creating Proof of concept	10
5.	Mini Project / Extra Experiments/ Virtual Lab	10
6.	GATE Based Assignment test/Tutorials etc	10
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5
8.	Multiple Choice Questions (Quiz)	5
9	Peer Review and participation	5/10

End Semester Theory Examination	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Course Title	Credit
ILO8023	Entrepreneurship Development and Management	3

Prerequisite: Computer Networks and Operating Systems.	
Course Objectives	
1	To acquaint with entrepreneurship and management of business
2	Understand Indian environment for entrepreneurship
3	Idea of EDP, MSME
Course Outcome	
1	Understand the Difference between Entrepreneur and Businessman
2	Understand the concept of business plan and ownerships
3	Importance of Women Entrepreneurs in Development
4	Interpret key regulations and legal aspects of entrepreneurship in India
5	Understand government policies for entrepreneurs
6	Concept of success in small business

Module	Content		Hours
1	**Overview of Entrepreneurship**		**04**
	1.1	Definitions, Businessman v/s entrepreneur, competencies , Roles and Functions of Entrepreneurship,	
	1.2	History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur	
	1.3	Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development:	
	1.4	Contribution of Government Agencies in Sourcing information for Entrepreneurship	
2	**Business Plans And Importance Of Capital To Entrepreneurship: Entrepreneurship And Business Development**		**09**
	2.1	Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements	

	2.2	Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur	
	2.3	Starting a New Business, Buying an Existing Business, New Product Development	
	2.4	Business Growth and the Entrepreneur Law and its Relevance to Business Operations	
3	**Women's Entrepreneurship Development**		**05**
	3.1	Social entrepreneurship-role and need	
	3.2	EDP cell, role of sustainability	
	3.3	sustainable development for SMEs, case studies, exercises	
4	**Indian Environment for Entrepreneurship:**		**08**
	4.1	key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc.,	
	4.2	Role of State governments in terms of infrastructure developments and support etc., Public private partnerships,National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
5	**Effective Management of Business**		**08**
	5.1	Issues and problems faced by micro and small enterprises and effective management of M and S enterprises	
	5.2	BCG matrix,risk management, credit availability, technology innovation,	
	5.3	Supply chain management, linkage with large industries, exercises, e-Marketing	
6	**Achieving Success In The Small Business**		**05**
	6.1	Stages of the small business life cycle, four types of firm-level growth strategies, Options	
	6.2	harvesting or closing small business Critical Success factors of small business	
		Total	**39**

Textbooks	
1	Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
2	Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
References	
1	T N Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
2	C N Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
3	Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
4	Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
5	Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
6	Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
7	Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
8	Laghu Udyog Samachar
9	www.msme.gov.in www.dcmesme.gov.in www.msmetraining.gov.in

Internal Assessment
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.
Continuous Assessment
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10
2	Wins in the event/competition/hackathon	10
3	Content beyond syllabus presentation	10
4	Creating Proof of concept	10
5	Mini Project / Extra Experiments/ Virtual Lab	10
6	GATE Based Assignment test/Tutorials etc	10
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5
8	Multiple Choice Questions (Quiz)	5
9	Peer Review and participation	5/10
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

Course Code	Course Title	Credit
ILO8029	Environmental Management	3

Prerequisite: Knowledge of Environmental Sciences	
Course Objectives	
1	Understand and identify environmental issues relevant to India and global concerns
2	Understand the global environmental concerns.
3	Learn concepts of ecology
4	Familiarise environment related legislations.
5	Understand concepts of quality management and corporate responsibilities
6	Learn all environmental acts
Course Outcomes	
1	Understand the concept of environmental management
2	Understand global warming, ozone depletion , and hazards.
3	Understand ecosystem and interdependence, food chain etc.
4	Understand and interpret environment related legislations.
5	Understand total quality management and ISO certification.
6	Understand acts related to air, water, pollution, factories, wildlife and forest protection.

Module	Content		Hours
1	**Introduction and Definition of Environment:**		**10**
	1.1	Significance of Environment Management for contemporary managers, Career opportunities.	
	1.2	Environmental issues relevant to India, Sustainable Development, the Energy scenario	
2	**Global Environmental concerns** :		**06**
	2.1	Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes.	
	2.2	Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	
3	**Concepts of Ecology**:		**05**

	3.1	Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity.	
4	**Scope of Environment Management**:		**10**
	4.1	Role & functions of Government as a planning and regulating agency.	
	4.2	Environment Quality Management and Corporate Environmental Responsibility	
5	**Total Quality Environmental Management**		**05**
	5.1	ISO-14000, EMS certification	
6	**General overview of major legislations**		**03**
	6.1	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc	
		Total	**39**

Reference Books

1	C J Barrow, Environmental Management: Principles and Practice, Routledge Publishers London, 1999
2	Jon C. Lovett and David G. Ockwell, A Handbook of Environmental Management, Edward Elgar Publishing
3	T V Ramachandra and Vijay Kulkarni, Environmental Management, TERI Press
4	Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5	S N Chary and Vinod Vyasulu, Environmental Management: An Indian Perspective, Maclillan India, 2000
6	Mary K Theodore and Louise Theodore, Introduction to Environmental Management, CRC Press Environment and Ecology, Majid Hussain, 3 rd Ed. Access Publishing 2015

Internal Assessment		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment		
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers.		
Sr No.	**Rubrics**	**Marks**
1	Content beyond syllabus presentation (case studies)	10
2	Multiple Choice Questions (Quiz)	10
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

Lab Code	Lab Name	Credit
CSL801	Distributed Computing Lab	1

Prerequisite: C Programming Language	
Lab Objectives	
1	To understand basic underlying concepts of forming distributed systems
2	To learn the concept of clock Synchronization
3	To learn Election Algorithms.
4	To explore mutual exclusion algorithms.
5	To study deadlock handling in the distributed system
6	To understand the Distributed File System
Lab Outcomes	
1	Develop test and debug using Message-Oriented Communication or RPC/RMI based client-server programs.
2	Implement techniques for clock synchronization
3	Implement techniques for Election Algorithms.
4	Demonstrate mutual exclusion algorithms .
5	Implement techniques of Deadlock handling in distributed system
6	Describe the concepts of distributed File Systems along with consistency management..

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	To implement a program to design a client server application using gRPC.
2	To implement a program to demonstrate Inter-process communication in Client Server Environment using gRPC. a. Server streaming RPCs b. Client Streaming and Bidirectional streaming
3	To implement MPI communication for efficient task scheduling between master and slaves for a distributed environment.
4	To implement a non-taken based distributed mutual exclusion and to demonstrate the message overhead complexity by increasing the no of nodes of communication.
5	To implement a Token based distributed mutual exclusion and to demonstrate the message overhead complexity by increasing the no of nodes of communication.

6	To implement a program to demonstrate Chandy Mishra Hass algorithm for Deadlock Management in Distributed Systems.
7	To implement a program to evaluate Load Balancing in distributed systems for Dynamic loads using various load balancing strategies. (at least 3)
8	To understand the concepts of distributed consistency management in distributed systems and to implement and observe different consistency models.
9	To study Distributed File System. a. To demonstrate Hadoop Distributed File System using basic commands b. To demonstrate Election algorithm in Zookeeper
10	Mini Project

Term Work	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSL801and CSC801

Lab Code	Lab Name	Credit
CSDL8011	Deep Learning Lab	1

Prerequisite: C Programming Language.	
Lab Objectives	
1	To implement basic neural network models for simulating logic gates.
2	To implement various training algorithms for feedforward neural networks.
3	To design deep learning models for supervised, unsupervised, and sequence learning.
Lab Outcomes	
1	Implement basic neural network models to learn logic functions.
2	Design and train feedforward neural networks using various learning algorithms.
3	Build and train deep learning models such as Autoencoders.
4	Build and train deep learning models such as CNNs, RNN, LSTM, and GRU.

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	McCulloch Pitts model using Virtual Lab 1. Implement McCulloch Pitts model for binary logic functions. 2. To explore Python libraries for deep learning e.g. Theano, TensorFlow, Lasagne , Keras, Scikit-learn, Caffe, MXNet etc.
2	Perceptron Model using Virtual Lab 1. Implement the Perceptron algorithm to simulate any logic gate. 2. Implement a Multilayer Perceptron algorithm to simulate the XOR gate
3	Training, Optimization, and Regularization of Deep Neural Network Apply any of the following learning algorithms to learn the parameters of the supervised single-layer feed-forward neural network. a. Stochastic Gradient Descent b. Mini Batch Gradient Descent c. Momentum GD d. Nestorev GD e. Adagrad GD f. Adam Learning GD
4	Implement a backpropagation algorithm to train a DNN with at least 2 hidden layers.
5	Design and implement a fully connected deep neural network with at least 2 hidden layers for a classification application. Use appropriate Learning Algorithm, output function, and loss function
6	Autoencoders 1. Design the architecture and implement the autoencoder model for Image

	Compression. 2. Design the architecture and implement the autoencoder model for Image denoising.
7	Convolutional Neural Networks (CNN) 1. Design and implement a CNN model for digit recognition applications. 2. Design and implement a CNN model for image classification.
8	Recurrent Neural Networks (RNN) (any two) 1. To design and implement RNN(Recurrent Neural Network) by using LSTM layer for Multiclass Classification on text data 2. To design and implement an RNN(Recurrent Neural Network) by using GRU layer for Multiclass Classification on text data 3. Implement Dinosaur Island - Character-Level Language Modeling using RNN
9	Case study on Transfer Learning
10	Mini Project focusing on Agriculture / Healthcare / Education /Society domain need to be carried out by the students by using the concepts of deep learning

Useful Links	
1	TensorFlow (www.tensorflow.org)
2	Keras (keras.io)
3	PyTorch (pytorch.org)
4	Scikit (https://scikit-learn.org/stable/)
5	OpenNN (www.opennn.net)
6	Theano https://github.com/Theano/Theano
7	Caffe https://caffe.berkeleyvision.org/
Math Links	
1	ConvNet Playground(https://github.com/fastforwardlabs/convnetplayground)
2	CNN (https://poloclub.github.io/cnn-explainer/)
3	GAN (https://poloclub.github.io/ganlab/)
4	https://github.com/openai/gym
Virtual Lab	
1	https://github.com/materialsvirtuallab/megnet
Datasets	
1	Kaggle Datasets, ImageNet, CIFAR-10 and CIFAR-100, COCO Dataset, MNIST, UCI Machine Learning Repository, QM7 Dataset, QMOF Dataset, EDNet Dataset

Term Work	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSDL8011and CSDC8011

Lab Code	Lab Name	Credit
CSDL8012	Digital Forensics Lab	1

Prerequisite: Computer Network, Cryptography and System Security	
Lab Objectives	
1	To demonstrate the procedures for identification, preservation, and acquisition of digital evidence.
2	To demonstrate techniques and tools used in digital forensics for operating systems and malware investigation.
3	To demonstrate tools for mobile forensics and browser, email forensics
4	To explore scenario based crime forensics investigations.
Lab Outcomes	
1	Explore various forensics tools and use them to acquire, duplicate and analyze data and recover deleted data.
2	Implement penetration testing using forensics tools.
3	Explore various forensics tools and use them to acquire and analyze live and static data.
4	Verification of source and content authentication of emails and browsers.
5	Demonstrate Timeline Report Analysis using forensics tools.
6	Discuss real time crime forensics investigations scenarios.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Analysis of forensic images using open source tools. ● FTK Imager ● Autopsy
2	Explore forensics tools in kali linux for acquiring, analyzing and duplicating data. ● dd ● dcfldd
3	Performing penetration testing using Metasploit - kali Linux.
4	Performing RAM Forensic to analyze memory images to find traces of an attack. ● Capturing RAM Using the DumpIt Tool ● Volatility tool
5	Network forensics using Network Miner.
6	Windows Recycle Bin Forensics
7	Data Carving using open source tools ● Foremost ● Scalpel

	● Jpg Carver
8	USB Device Forensics using ● USBDeview ● USB Detective
9	Web Browser Forensics using DB Browser for SQLite
10	Generate a Timeline Report Using Autopsy
11	Email Analysis
12	Case Study

Term Work	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSDC8012 and CSDL 8012

Lab Code	Lab Name	Credit
CSDL8013	Applied Data Science Lab	1

Prerequisite: Engineering Mathematics, Machine Learning, Programming fundamentals	
Lab Objectives	
1	To explore various stages in the data science lifecycle
2	To understand data preparation, exploration and visualization techniques.
3	To model and evaluate different supervised/unsupervised learning techniques
Lab Outcomes	
1	Apply various stages of the data science lifecycle for the selected case study.
2	Apply inferential statistics, predictive analytics, and data mining to informatics-related field
3	Demonstrate data preparation, exploration and visualization techniques
4	Implement and evaluate different supervised and unsupervised techniques.

Suggested Experiments: Students are required to complete at least 8 experiments.

Sr. No.	Name of the Experiment
1	Explore the descriptive and inferential statistics on the given dataset.
2	Apply data cleaning techniques (e.g. Data Imputation)
3	Explore data visualization techniques.
4	Implement and explore performance evaluation metrics for Data Models (Supervised/Unsupervised Learning)
5	Use SMOTE technique to generate synthetic data.(to solve the problem of class imbalance)
6	Outlier detection using distance based/density based method.
7	Implement time series forecasting for Healthcare diagnosis
8	Illustrate data science lifecycle for selected case study. (Prepare case study document for the selected case study) Suggested Case Studies: 1. Customer Segmentation 2. Fraud Detection 3. House Price prediction 4. Product Recommendation 5. Stock price prediction 6. Weather prediction

Useful Links	
1	https://www.microsoft.com/en-in/download/details.aspx?id=45331
2	https://rapidminer.com/
3	https://www.knime.com/

Term Work	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSDL8013and CSDC8013

Lab Code	Lab Name	Credit
CSDL8021	Optimization in Machine Learning Lab	1

Prerequisite: Engineering Mathematics, Algorithms and data structures	
Lab Objectives	
1	To apply derivative based optimization techniques
2	To understand evolutionary optimization to a given machine learning problem.
3	To apply advanced evolutionary optimization
4	To design and analyze optimization problems for real world applications
Lab Outcomes	
1	To implement derivative based optimization techniques
2	To implement evolutionary optimization
3	To implement advanced evolutionary optimization
4	To apply efficient optimization algorithm for real world applications

Suggested Experiments: Students are required to complete at least 8 experiments.

Sr. No.	Name of the Experiment
1	To implement Gradient Descent algorithm
2	To implement the Stochastic Gradient Descent algorithm
3	To implement Newton method
4	To apply Genetic Algorithm for real world problem
5	To compare and implement different selection mechanism using genetic algorithm
6	To implement various mutation and crossover mechanisms
7	To implement Particles Swarm optimization
8	To implement Ant colony optimization

Term Work	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.

3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSDL8021 and CSDC8021
Useful Links and Tools	
1	https://arxiv.org/abs/2202.02414
2	https://scikit-optimize.github.io/stable/
3	https://shorturl.at/TAPLo

Lab Code	Lab Name	Credit
CSDL8022	High Performance Computing Lab	1

Prerequisite: C Programming	
Lab Objectives	
1	Enable students to build the logic to parallelize the programming task.
2	Give insight about performance of parallel computing systems.
3	Provide hands-on experience on parallel programming platforms/frameworks
Lab Outcomes	
1	Perform Linux based commands on remote machine
2	Compare the performance of sequential algorithms with parallel algorithms in terms of execution time, speedup and throughput.
3	Implement parallel program using OpenMP library and analyze its performance
4	Implement parallel program using MPIplatform and analyze its performance
5	Implement parallel program using OpenCL framework and analyze its performance
6	Implement parallel program using CUDA framework and analyze its performance

Suggested Experiments: Students are required to complete at least 8 experiments..	
Sr. No.	**Name of the Experiment**
1	To analyse the Linux based computer systems using following commands: a. top , b.ps , c. kill, d. cat /proc/cpuinfoe.vmstat Hardware/Software Requirement: Linux Operating System
2	To set up SSH passwordless logins for two or more Linux based machines and execute commands on a remote machine. Hardware/Software Requirement: Linux Operating System, Multi-core computer systems
3	Write a program in C to multiply two matrices of size 10000 x 10000 each and find its execution-time using the "time" command. Try to run this program on two or more machines having different configurations and compare execution-times obtained in each run. Comment on which factors affect the performance of the program. Hardware/Software Requirement: Linux Operating System, gcc compiler,Multi-core computer systems
4	Writing a "Hello World" program using the OpenMP library also displays the number of threads created during execution. Hardware/Software Requirement**:** Linux Operating System, gcc compiler,Dual core with HT or Quad-core or higher computer system.

5	Write a parallel program to calculate the value of PI/Area of Circle using OpenMP library. Hardware/Software Requirement: Linux Operating System, gcc compiler,Dual core with HT or Quad-core or higher computer system
6	Write a parallel program to multiply two matrices using openMP library and compare the execution time with its serial version. Also change the number of threads using omp_set_num_threads() function and analyse how thread count affects the execution time. Hardware/Software Requirement: Linux Operating System, gcc compiler,Dual core with HT or Quad-core or higher computer system.
7	Install MPICH library and write a "Hello World" program for the same. Hardware/Software Requirement: Linux Operating System, MPICH, Multi-processor systems or MPI Cluster.
8	Write a parallel program to multiply two matrices using MPI library and compare the execution-time with its OpenMP and serial version. Hardware/Software Requirement: Linux Operating System, MPICH, gcc, Multi processor systems, or MPI Cluster.
9	Implement a parallel program to demonstrate the cube of N number within a set range using MPI/OpenMP/OpenCL/CUDA. Hardware/Software Requirement: Linux Operating System, MPICH, Multi-processor systems or MPI Cluster. A CUDA-capable GPU,A supported version of Microsoft Windows,A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit
10	Implement Two Vector addition using OpenCL/CUDA/ Parallel Matlab Hardware/Software Requirement: A CUDA-capable GPU, A supported version of Microsoft Windows,A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit

Term Work	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSDL 8022and CSDC 8022

Lab Code	Lab Name	Credit
CSDL8023	Social Media Analytics Lab	1

Prerequisite: Types of Graphs, Data Mining, Data Analytics	
Lab Objectives	
1	To understand the fundamental concepts of social media networks.
2	To learn various social media analytics tools and evaluation matrices.
3	To collect and store social media data.
4	To analyze and visualize social media data
5	To design and develop social media analytics models.
6	To design and build a social media analytics application.
Lab Outcomes	
1	Understand characteristics and types of social media networks.
2	Use social media analytics tools for business
3	Collect, monitor , store and track social media data
4	Analyze and visualize social media data from multiple platforms
5	Design and develop content and structure based social media analytics models.
6	Design and implement social media data based predictive analytics application for business intelligence**.**

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Study various - i) Social Media platforms (Facebook, twitter, YouTube etc) ii) Social Media analytics tools (Facebook insights, google analytics net lyticetc , **social media scheduling and monitoring tools**) iii) Social Media Analytics techniques and engagement metrics (page level, post level, member level) iv) Applications of Social media analytics for business. e.g. Google Analytics https://marketingplatform.google.com/about/analytics/ https://netlytic.org/
2	Data Collection from multiple channels -Select the social media platforms of your choice (Twitter,Facebook, LinkedIn, YouTube, Web blogs etc) ,connect to and capture social media data for business (scraping, crawling, parsing)
3	Data Cleaning and Storage- Preprocess, filter and store social media data for

	business (Using Python, MongoDB, R , Vectorized data store etc).
4	Exploratory Data analysis and visualization of Social Media Data for business using PowerBI/ python.
5	Develop Content (text, emoticons, image, audio, video) based social media analytics model for businesses (e.g. Content Based Analysis :Topic , Issue ,Trend, sentiment/opinion analysis, audio, video, image analytics)
6	Implement Structure based social media network models , Identify Node, Degree, Betweenness centrality of given social network data and identify influencer .
7	Implement Community Detectation/ Clustering algorithm for social media data for any business
8	Create Predictive predictive model based on social media action data.
9	Develop social media text analytics models for comparing competitors and your existing product/service by analyzing customers reviews/ comments. using python .
10	Develop social media analytics application for social benefit/ government.

Reference Books	
1	Python Social Media Analytics: Analyze and visualize data from Twitter, YouTube, GitHub, and more Kindle Edition by Siddhartha Chatterjee , Michal Krystyanczuk
2	Learning Social Media Analytics with R,byRaghav Bali, Dipanjan Sarkar, Tushar Sharma.
3	Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013
4	Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013
5	Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011
Useful Links	
1	https://analytics.google.com/analytics/web/
2	https://www.similarweb.com/
3	https://www.microsoft.com/en-in/download/details.aspx?id=45331
4	https://netlytic.org/
5	https://apify.com/
6	https://www.brand24.com/
7	https://www.semrush.com/
8	https://trends.google.com/trends/
AI Tools	

1	https://www.brandwatch.com/
2	https://sproutsocial.com/
3	https://www.socialbakers.com/
4	https://hootsuite.com/platform/insights
Case Studies	
1	https://ideas.repec.org/a/aag/wpaper/v25y2021i2p51-73.html
2	https://barnraisersllc.com/2015/11/23/7-case-studies-show-social-media-analytics-pay-off/

Term Work	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam	
1	Based on the subject and related lab of CSDL8023 and CSDC 8023

Course Code	Course Title	Credit
CSP801	Major Project 2	6

The objective is to meet the milestones formed in the overall project plan decided in Project - I. The idea presented in Project -I should be implemented in Project -II with results, conclusion and future work. The project will culminate in the production of a thesis by each individual student.

Course Objectives	
1	To identify and define an appropriate problem statement.
2	To perform extensive literature survey and feasibility study for the chosen problem statement.
3	To propose suitable methodology for solving the defined problem.
4	To design and implement solutions which will impact society and the environment in a positive manner.
5	To inculcate team spirit, professional, ethical behavior and leadership skills
6	To create well formatted documents using standard engineering practices
Course Outcomes	
1	Develop the understanding of the problem domain through extensive review of literature.
2	Identify and analyze the problem in detail to define its scope with problem specific data.
3	To know various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4	To design solutions for real-time problems that will positively impact society and the environment..
5	To develop clarity of presentation based on communication,teamwork and leadership skills.
6	To inculcate professional and ethical behavior.

Guidelines

Project Report Format:
At the end of semester a student needs to prepare a project report as per the guidelines issued. Along with the project report a CD containing: project documentation, Implementation code, required utilities, Software's and user Manuals need to be attached.

A project report should preferably contain at least following details:
1. Introduction
2. Literature Survey
3. Requirement Gathering for the Proposed System
4. Proposed Design

5. Implementation of the Proposed System
6. Testing of the Proposed System
7. Results and Discussion
8. Conclusion
9. References

Term Work: (100)

Students have to submit a weekly progress report to the internal guide and the internal guide has to keep track of the progress of the project and also has to maintain attendance reports.

This progress report can be used for awarding term work marks. In case of industry projects, visits by an internal guide will be preferred to get the status of the project.

Distribution of marks for term work shall be as follows:

a) Weekly Attendance on Project Day
b) Project work contributions as per objective
c) Project Report (Hard Bound)
d) Term End Presentation (Internal)
e) Mid term Review
f) Paper Publications
OR
e)Effort taken by students

- **Paper publish/publishing patent/creation of product/start-up**
- **Idea/project/poster/TPP competition (National/international)**

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Oral and Practical

Oral & Practical :

Oral & Practical examination of Project- II should be conducted by Internal and External examiners approved. Students have to give presentation and demonstration on the Project II