CURRICULUM STRUCTURE

FINAL YEAR UG: B.E.

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

REVISION: FRCRCE-1-24

Effective from Academic Year 2024-25
Board of Studies Approval: 08/03/2024
Academic Council Approval: 16/03/2024

Dr.DEEPAK BHOIR
Dean Academics

Dr. Jagruti Save
HOD(AI&DS)

DR. SURENDRA RATHOD
Principal

Preamble:

Greetings and congratulations to all the education partners Fr Conceicao Rodrigues College of Engineering for getting autonomous status to the college from the year 2024-25. University Grant Commission vide letter No. F. 2-10/2023(AC-Policy) dated 23rd Nov 2023 conferred the autonomous status to Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai 400050 affiliated to University of Mumbai for a period of 10 years from the academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations,2023. We look towards autonomy as a great opportunity to design and implement curriculum sensitive to needs of Learner, Indian Society and Industries.

All India Council for Technical Education (AICTE) has made implementation of Internship policy mandatory for students. While applying for Extension of Approval (EoA) it is desired that institute has already implemented compulsory internship for all final year students.

The National Education Policy (NEP), 2020 suggests that students must actively engage with the practical side of their learning as part of a holistic education to further improve their employability. It states that students at all HEIs will be provided with opportunities for internships with local industry and businesses as well as research internships with faculty and researchers at their own or other HEIs/research institutions.
In line with the NEP and tracing the provisions of NcrF, Government of Maharashtra has subsequently released two Government Resolutions (GRs) (NEP GR dated – 1. 20 April 2023, and 2. 4 July 2023) to reinforce NEP implementation and credit revision across Maharashtra HEIs. These GRs lay out detailed guidelines for curriculum interventions.

Fr. CRCE has taken a strategic move as a response to the NEP's call for students to engage with practical learning through internships, a practice proven to enhance employability and refine skill sets for the final year students from academic year 2024-25.

Following two major changes applicable for Final Year Students of 2024-25 and 2025-26 batch:

1. Semester long internship option

2. Revised assessment in the form of ISE-1, MSE, ISE-2 and ESE to be taken by the college.

I. Internship:

Following are the objectives of the Internships envisaged for the students:

- ✓ Exposing students to industrial environments that cannot be replicated in a classroom or lab.
- ✓ Providing opportunities to acquire and refine analytical and managerial skills crucial for a professional career.
- ✓ Offering hands-on experience in teamwork, thereby enhancing professional skills like communication, work ethics, conflict resolution, etc., with a lasting impact on lifelong learning and professional development.
- ✓ The general idea is to enable students to undertake immersive assignments within the organizations for a limited period.
- ✓ Establishing links between students and potential future job or research opportunities.

Methodology of Implementation of Internship Policy for Final Year Students of 2024-25:

A. Completion of Existing Credits:

1. Semester VIII will be conducted in Fast Track Mode during first week of July and winter vacation for completing Institute Level Elective common course to all the departments.
2. Each course will be conducted in a continuous training format for 10days (3hrs theory+2hours lab).
3. Honors course will be taken for two hours each day during Fast Track Mode.
4. Major project will be continued till the official semester end. Assessment of major project will be conducted in phase-wise manner. Students need to compulsorily present in person for each of the phases of assessment.
5. If required then provision for SWAYAM courses to be explored by departments
6. Assessments to be completed immediately after completion of all courses.
7. Release of Gazette and score cards will be only at the end of academic year

B. Internship Details:

1. Training and placement department shall contact companies and strive for providing Six months internship to all the students. Preference should be given to Internship+PPO during regular placement cycle in SEM VII.
2. Internships should be an integral part of the academic curricula. But for 2024-25 and 2025-26 batch of Final Year students, credit framework is already given by University of Mumbai. For student of these batches internship is last moment value addition and therefor it will not be a part of credit framework. College is providing this as an additional experiential learning opportunity for the students by considering Market demand, Industry demand, Government Resolutions and Student desire.
3. Following are the types of internship opportunities that can be explored by students:
    a. Offered by Industry Govt./ NGO/MSME
    b. Research Institutes like BARC, TIFR, SAMEER and IITs
    c. At various Incubation Centres
    d. Internships offered through academic collaborations with Foreign Universities
    e. Internships offered by reputed colleges with whom MoUs are signed for the collaboration and credit exchange
    f. Or any other internship approved by HoI based on the merit of offer
4. All internships are subjected to approval of Head of the Institute. Students must take prior approval from college before starting internship
5. Students opting for Entrepreneurship or Start-up are exempted from internship; however, they have to work in the pre-incubation centre of the college to work for their start-up initiative with demonstrable output.
6. Students who wish to work on academic / industry research project (Rather than other internships) assigned under a faculty of Fr CRCE is allowed to do so provided details of work to be done and outcomes are clearly stated and approved by the college authorities.
7. Students can proceed for Internships from 15th Jan.
8. On the request of student college will issue successful completion certificate after achieving predefined approved milestones of Internship/Entrepreneurship/Research Project etc.

Student Resources:

Government Internship Programs:

- ✓ AICTE Internship: https://internship.aicte-india.org/
- ✓ NITI Ayog Internship: https://www.niti.gov.in/internship
- ✓ TULP Internship Program: https://smartcities.gov.in/The_Urban_Learning_Internship_Program

- ✓ Digital India Internship: https://www.meity.gov.in/writereaddata/files/Digital%20Internship%20Scheme%202023%20%281%29.pdf
- ✓ Directorate General of Foreign Trade Internship program: https://www.dgft.gov.in/CP/?opt=intership-scheme
- ✓ National Commission for Scheduled Tribes Internship: https://ncst.nic.in/sites/default/files/2021/Internship/3677
- ✓ Corporate Affairs Ministry Internship program: https://www.mca.gov.in/bin/dms/getdocument?mds=aC%252B%252F82boz%252FD%252FdHcFkAAJ0A%253D%253D&type=open
- ✓ Finance Ministry Internship program: https://dpe.gov.in/schemes/scheme-internship
- ✓ Women and Child Development Ministry Internship program: https://wcd.nic.in/sites/default/files/Internship%20Guideline.._0.pdf
- ✓ Ministry of Culture Internship programs: https://nationalmuseumindia.gov.in/en/national-museum-internship-programme

Online Platforms for Internships:

- ✓ Internshala: https://internshala.com/
- ✓ LetsIntern: https://letsintern.in/
- ✓ Twenty19: http://twenty19.com.testednet.com/
- ✓ HelloIntern: https://hellointern.co/
- ✓ Freshersworld: https://www.freshersworld.com/
- ✓ Youth4work: https://www.youth4work.com/
- ✓ Freshersnow: https://www.freshersnow.com/internships-in-delhi/
- ✓ Zuno by Foundit: https://www.foundit.in/zuno/
- ✓ LinkedIn: https://www.linkedin.com/jobs/internshipjobs/?currentJobId=3647611763&originalSubdomain=in
- ✓ Well Found (earlier, AngelList Talent): https://wellfound.com/location/india
- ✓ Indeed: https://in.indeed.com/jobs?q=internships&l=&vjk=fd2d4f96a2564717
- ✓ Naukri.com: https://www.naukri.com/internship-jobs
- ✓ TimesJobs: https://www.timesjobs.com/jobs-by-roles/intern-jobs
- ✓ NGO Box: https://ngobox.org/job_listing.php
- ✓ CSR Box: https://csrbox.org/

II. Honours and Minor Degree Eligibility Criteria for Students:

i. Following is the eligibility criteria for students opting the Honours/ Minor Degree program:

a. Students with no backlog in semester I, II, and III

b. The CGPI (based on semester I, II, and III) of the students must be 6.75 and above

c. For direct second year (DSE) admitted students - No backlog in semester III and CGPI must be 6.75 and above

ii) Each eligible student can opt for maximum one Honour's or one Minor Programs at any time.

iii) However, it is optional for leaners to take Honours/Minor degree program.

iv) The Honours/ Minor degree program can be opted only during regular engineering studies

v) The student have to complete the Honours/ Minor degree program in stipulated four semesters only.

Note:

1. Courses offered during internship semester shall be in online mode
2. Technical support team for registration of Academic Bank of Credits (ABC), registration of elective/optional courses, registration of online courses, registration for degree options etc. under supervision of Dean Academics.

SEMESTERWISE CURRICULUM STRUCTURE

FINAL YEAR Artificial Intelligence and Data Science Program:

SEM-VII									
Course Code	Course Name		Contact Hours	Examination Marks					Credits
				ISE1	MSE	ISE2	ESE	Total	Total
CSC701	Deep Learning	TH	3	20	30	20	30	100	3
CSC702	Big Data Analytics	TH	3	20	30	20	30	100	3
CSDO701X	Department Level Optional Course - 3	TH	3	20	30	20	30	100	3
CSDO702X	Department Level Optional Course -4	TH	3	20	30	20	30	100	3
ILO 701X	Institute Level Optional Course- 1	TH	3	20	30	20	30	100	3
CSL701	Deep Learning Lab	PR	2	20	--	30	--	50	1
CSL702	Big Data Analytics Lab	PR	2	20	--	30	--	50	1
CSDOL701X	Department Level Optional Course-3 Lab	PR	2	10	--	15	--	25	1
CSDOL702X	Department Level OptionalCourse-4 Lab	PR	2	10	--	15	--	25	1
CSP701	Major Project1	PR	6	15	--	20	40	75	3
		Total	**TH:TU:PR 15:0:14**			**-**	**-**	**725**	**22**

Department Level Optional Courses:

Department/ Institute OptionalCourses and Labs	Subject and Labs
Department Optional Course -3	CSDO7011: Natural Language Processing CSDO7012.: AI for Healthcare CSDO7013: Neural Network & Fuzzy System
Department Optional Lab -3	CSDOL7011: Natural Language Processing Lab CSDOL7012.: AI for Healthcare Lab CSDOL7013: Neural Network & Fuzzy System
Department Optional Course -4	CSDO7021: User Experience Design with VR CSDO7022: Blockchain Technologies CSDO7023: Game Theory for Data Science
Department Optional Lab -4	CSDOL7021: User Experience Design with VR Lab CSDOL7022: Blockchain Technologies Lab CSDOL7023: Game Theory for Data Science Lab

Institute level Optional Courses-1	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

SEM-VIII									
Course Code	**Course Name**		**Contact Hours**	**Examination Marks**					**Credits**
				ISE1	MSE	ISE2	ESE	Total	Total
CSC801	Advanced Artificial Intelligence	TH	3	20	30	20	30	100	3
CSDO801X	Department Level Optional Course-5	TH	3	20	30	20	30	100	3
CSDO802X	Department Level OptionalCourse-6	TH	3	20	30	20	30	100	3
ILO 801X	Institute Level OptionalCourse-2	TH	3	20	30	20	30	100	3
CSL801	Advanced Artificial Intelligence Lab	PR	2	20	--	30	--	50	1
CSDOL801X	Department Level Optional Course-5 Lab	PR	2	20	--	30	--	50	1
CSDOL802X	Department Level Optional Course-6 Lab	PR	2	20	--	30	--	50	1
CSP801	Major Project-2	PR	12	50	--	50	50	150	6
	Total		**TH:TU:PR 12:0:18**			**-**	**-**	**700**	**21**

Department Level Optional Courses:

Department/ Institute OptionalCourses and Labs	**Subject and Labs**
Department Optional Course -5	CSDO8011: AI for financial & Banking application CSDO8012: Quantum Computing CSDO8013: Reinforcement Learning
Department Optional Lab -5	CSDOL8011: AI for financial & Banking application Lab CSDOL8012: Quantum Computing Lab CSDOL8013: Reinforcement Learning Lab
Department Optional Course -6	CSDO8021: Graph Data Science CSDO8022: Recommendation Systems CSDO8023: Social Media Analytic
Department Optional Lab -6	CSDOL8021: Graph Data Science Lab CSDOL8022: Recommendation Systems Lab CSDOL8023: Social Media Analytic Lab
Institute level Optional Courses-2	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

Honors Degree Offered to AI&DS Students from SEM-V to SEM-VIII:

A. Name:**Internet of Things**

1. SEM-V: HIoTC501: IoT Sensor Technologies
2. SEM VI: HIoTC601:IoT System Design
3. SEM VII: HIoTC701:Dynamic Paradigm in IoT
4. SEM VII: HIoTSBL701:Interfacing & Programming with IoTLab (SBL)
5. SEM VIII: HIoTC801: Industrial IoT

B. Name: Blockchain

1. SEM-V: HBCC501: Bit coin and Crypto currency
2. SEM VI: HBCC601: Blockchain Platform
3. SEM VII: HBCC701: Blockchain Development
4. SEM VII: HBCSBL701: Private Blockchain Setup Lab (SBL)
5. SEM VIII: HBCC801: DeFi(Decentralized Finance)

C. Name: Cyber Security

1. SEM-V: HCSC501: Ethical Hacking
2. SEM VI: HCSC601: Digital Forensic
3. SEM VII: HCSC701: Security Information Management
4. SEM VII: HCSSBL601:Vulnerability Assessment Penetration Testing (VAPT) Lab
5. SEM VIII: HCSC801: Application Security

Minors Degree Offered to ECS Students from SEM-V to SEM-VIII:

A. Name: **Robotics**

1. SEM-V: HRBC501: Industrial Robotics
2. SEM VI: HRBC601:Mechatronics & IoT
3. SEM VII: HRBC701:Artificial Intelligence & Data Analysis
4. SEM VII: HRBSBL701:Robotics and Automation Lab
5. SEM VIII: HRBC801: Autonomous Vehicle Systems

B. Name:3D Printing

1. SEM-V: H3DPC501: Introduction to CAD
2. SEM VI: H3DPC601:3D Printing: Introduction & Processes
3. SEM VII: H3DPC701:Applications of 3D Printing
4. SEM VIII: H3DPSBL701:Skill Based Lab– Digital Fabrication
5. SEM VIII: H3DPC801: 3D Printing in Medical Technology

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSC701	Deep Learning	L	T	P	L	T	P	Total
		3	--		3	--		3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100 (30% weightage)		100

Pre-requisite Course Codes		Basic mathematics and Statistical concepts, Linear algebra, Machine Learning (CSC301 ,CSC401,CSC604)
Course Outcomes	CO1	Gain basic knowledge of Neural Networks.
	CO2	Acquire in depth understanding of training Deep Neural Networks.
	CO3	Design appropriate DNN model for supervised, unsupervised and sequence learning applications.
	CO4	Gain familiarity with recent trends and applications of Deep Learning.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Fundamentals of Neural Network**	3,4	4
	1.1	History of Deep Learning, Deep Learning Success Stories, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks		
	1.2	Deep Networks: Three Classes of Deep Learning Basic Terminologies of Deep Learning		
2		**Training, Optimization and Regularization of Deep Neural Network**	1	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**	1	6

	3.1	Introduction, Linear Auto encoder, Under complete Auto encoder, Over complete Auto encoders, Regularization in Auto encoders.		
	3.2	Denoising Auto encoders, Sparse Auto encoders, Contractive Auto encoders		
	3.3	Application of Auto encoders: Image Compression		
4		**Convolutional Neural Networks (CNN): Supervised Learning**	1	7
	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, Multichannel convolution operation,2D convolution.		
	4.2	Modern Deep Learning Architectures: LeNET: Architecture, AlexNET: Architecture, ResNet : Architecture		
5		**Recurrent Neural Networks (RNN)**	1	8
	5.1	Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation Through Time (BTT), Limitation of " vanilla RNN" Vanishing and Exploding Gradients, Truncated BTT		
	5.2	Long Short Term Memory(LSTM): Selective Read, Selective write, Selective Forget, Gated Recurrent Unit (GRU)		
6		**Recent Trends and Applications**	1	4
	6.1	Generative Adversarial Network (GAN): Architecture		
	6.2	Applications: Image Generation, DeepFake.		
			Total	39

Course Assessment:

ISE-1:

Quiz – (10 Marks)

Activity : Assignment - (10 Marks)

ISE-2:

Case Study(10 Marks)

Activity: Critical appreciation of an article in the report form(10 Marks)

MSE: 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

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.

Reference Books:

1. Deep Learning from Scratch: Building with Python from First Principles- Seth Weidman by O`Reilley
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. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India
6. D.Tang, Chi-FengPai, Wiley online Library
7. Resistive Switching: From Fundamentals of Nanoionic Redox Processes to Memristive Device Applications, Daniel Ielmini, Rainer Waser, Wiley online Library

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSC 702	Big Data Analytics	L	T	P	L	T	P	Total
		3	--		3	--		3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes	Some prior knowledge about Java programming, Basics of SQL, Data mining and machine learning methods would be beneficial(CSL304,CSC403 ,CSC504,CSC604)	
Course Outcomes	CO1	Understand the key issues in big data management and its associated applications for business decisions and strategy.
	CO2	Develop problem solving and critical thinking skills in fundamental enabling techniques like Hadoop, Map reduce and NoSQL in big data analytics
	CO3	Collect, manage, store, query and analyze various forms of Big Data
	CO4	Interpret business models and scientific computing paradigms, and apply software tools for big data analytics
	CO5	Adapt adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.
	CO6	Solve Complex real world problems in various applications like recommender systems, social media applications, health and medical systems, etc

Module No.	Unit No.	Topics	Ref	Hrs.
1		**Introduction to Big Data & Hadoop**	1,2	4
	1.1	Introduction to Big Data		
	1.2	Big Data characteristics, types of Big Data,		
	1.3	Traditional vs. Big Data business approach,		
	1.4	Case Study of Big Data Solutions.		
	1.5	Concept of Hadoop		
	1.6	Core Hadoop Components; Hadoop Ecosystem		
2		**Hadoop HDFS and Map Reduce**	2	7
	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 Failure		

	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**	3	5
	3.1	Introduction to NoSQL, NoSQL Business Drive		
	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; NoSQL systems to handle big data problems. peer-to-peer; Four ways that NoSQL systems handle big data problems		
4		**Mining Data Streams**	1	9
	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 Frequent Items in a Stream, Sampling Methods for Streams, Frequent Itemsets in Decaying Windows		
	4.6	Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM algorithm, Decaying Windows.		
5		**Finding Similar Items and Clustering**	1	6
	5.1	Distance Measures: Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance.		
	5.2	CURE Algorithm, Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries		
6		**Real-Time Big Data Models**	1	8
	6.1	PageRank Overview, Efficient computation of PageRank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector.		
	6.2	A Model for Recommendation Systems,Content-Based Recommendations, Collaborative Filtering		

	6.3	Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph		
		Total		39

Course Assessment:

ISE-1:

Quiz – (10 Marks)

Activity :Case Study- (10 Marks)

ISE-2:

Quiz(10 Marks)

Activity: Seminar on the topic that is content beyond syllabus(10 Marks)

MSE: 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

1. Anand Rajaraman and Jeff Ullman ―Mining of Massive Datasets, Cambridge University Press,
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 Pressn.

Reference Books:

1. Bill Franks , ―Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics, Wiley
2. Chuck Lam, ―Hadoop in Action, 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, MIT Press, 2010

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDO7011	Natural Language Processing	L	T	P	L	T	P	Total
		3	--		3	--		3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		Artificial Intelligence and Machine Learning, Basic knowledge of Python (CSC503,CSC604,CSL405)
Course Outcomes	CO1	Describe the steps of natural language processing and its real-world applications
	CO2	Design language model for word level analysis of given text data.
	CO3	Demonstrate various POS tagging techniques and parsers to get grammatical structure of language
	CO4	Do semantic and pragmatic analysis of text data
	CO5	Formulate the discourse segmentation and anaphora resolution.

Module No.	Unit No.	Topics	Ref	Hrs.
1		**Introduction**	1	4
	1.1	Origin & History of NLP, The need of NLP, Generic NLP System, Levels of NLP, Knowledge in Language Processing, Ambiguity in Natural Language, Challenges of NLP, Applications of NLP.		
2		**Word Level Analysis**	1	8
	2.1	Tokenization, Stemming, Segmentation, Lemmatization, Edit Distance, Collocations, Finite Automata, Finite State Transducers (FST), Porter Stemmer, Morphological Analysis, Derivational and Reflectional Morphology, Regular expression with types		
	2.2	N –Grams, Unigrams/Bigrams Language Models, Corpora, Computing the Probability of Word Sequence, Training and Testing		
3		**Syntax analysis**	1	8
	3.1	Part-Of-Speech Tagging (POS) - Open and Closed Words. Tag Set for English (Penn Treebank), Rule Based POS Tagging, Transformation Based Tagging, Stochastic POS Tagging and Issues –Multiple Tags & Words, Unknown Words		
	3.2	Introduction to CFG, Hidden Markov Model (HMM), Maximum Entropy, And Conditional Random Field (CRF)		
4		**Semantic Analysis**	1,2	8

	4.1	Introduction, meaning representation; Lexical Semantics; Corpus study; Study of Various language dictionaries like WordNet, Babelnet; Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy; Semantic Ambiguity		
	4.2	Word Sense Disambiguation (WSD); Knowledge based approach (Lesk's Algorithm), Supervised (Naïve Bayes, Decision List), Introduction to Semi-supervised method (Yarowsky), Unsupervised (Hyperlex)		
5		**Pragmatic & Discourse Processing**	1,2	6
	5.1	Discourse: Reference Resolution, Reference Phenomena, Syntactic & Semantic constraint on coherence; Anaphora Resolution using Hobbs and Cantering Algorithm		
6		**Applications (preferably for Indian regional languages)**	1	5
	6.1	Machine Translation, Information Retrieval, Question Answers System, Categorization, Summarization, Sentiment Analysis, Named Entity Recognition		
	6.2	Linguistic Modeling – Neurolinguistics Models- Psycholinguistic Models – Functional Models of Language – Research Linguistic Models- Common Features of Modern Models of Language		
			Total	39

Course Assessment:

ISE-1: Quiz (10 Marks)
Activity: Assignment (10 Marks)
ISE-2: Quiz (10 Marks)
Activity: Assignment (10 Marks)
MSE: 30 Marks written examination based on 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

1. Daniel Jurafsky, James H. and Martin, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and HinrichSchutze, Foundations of Statistical Natural Language

Reference Books:

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. Nitin Indurkhya and Fred J. Damerau, ―Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDO7012	AI for Healthcare	L	T	P	L	T	P	Total
		3	--		3	--		3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		Artificial Intelligence, Machine Learning(CSC503,CSC604)
Course Outcomes	CO1	Understand the role of AI and ML for handling Healthcare data.
	CO2	Apply Advanced AI algorithms for Healthcare Problems.
	CO3	Learn and Apply various Computational Intelligence techniques for Healthcare Application.
	CO4	Use evaluation metrics for evaluating healthcare systems.
	CO5	Develop NLP applications for healthcare using various NLP Techniques.
	CO6	Apply AI and ML algorithms for building Healthcare Applications

Module No.	Unit No.	Topics	Ref	Hrs.
1		**Introduction**	1	6
	1.1	Overview of AI , ML and DL ,A Multifaceted Discipline, Applications of AI in Healthcare -Prediction, Diagnosis, personalized treatment and behavior modification, drug discovery, followup care etc		
	1.2	Realizing potential of AI in healthcare, Healthcare Data - Use Cases.		
2		**AI, ML, Deep Learning and Data Mining Methods for Healthcare**	1	8
	2.1	Knowledge discovery and Data Mining, ML, Multi classifier Decision Fusion, Ensemble Learning, Meta-Learning and other Abstract Methods.		
	2.2	Evolutionary Algorithms, Illustrative Medical Application-Multiagent Infectious Disease Propagation and Outbreak Prediction, Automated Amblyopia Screening System etc.		
	2.3	Computational Intelligence Techniques, Deep Learning, Unsupervised learning, dimensionality reduction algorithms.		
3		**Evaluating learning for Intelligence**	1	4
	3.1	Model development and workflow, evaluation metrics, Parameters and Hyperparameters, Hyperparameter tuning algorithms, multivariate testing, Ethics of Intelligence.		
4		**Natural Language Processing in Healthcare**	1	8
	4.1	NLP tasks in Medicine, Low-level NLP components, High level NLP components, NLP Methods.		

	4.2	Clinical NLP resources and Tools, NLP Applications in Healthcare. Model Interpretability using Explainable AI for NLP applications		
5		**Intelligent personal Health Record**	1	5
	5.1	Introduction, Guided Search for Disease Information, Recommending SCA's Recommending HHP's , Continuous User Monitoring.		
6		**Future of Healthcare using AI**	2	8
	6.1	Evidence based medicine, Personalized Medicine, Connected Medicine, Digital Health and Therapeutics, Conversational AI, Virtual and Augmented Reality, Blockchain for verifying supply chain, patient record access, Robot - Assisted Surgery, Smart Hospitals, Case Studies on use of AI and ML for Disease Risk Diagnosis from patient data, Augmented reality applications for Junior doctors.		
	6.2	Blockchain for verifying supply chain, patient record access, Robot - Assisted Surgery, Smart Hospitals, Case Studies on use of AI and ML for Disease Risk Diagnosis from patient data, Augmented reality applications for Junior doctors.		
			Total	39

Course Assessment:

ISE-1: Quiz (10 Marks)
Activity: Assignment (10 Marks)
ISE-2: Quiz (10 Marks)
Activity: Assignment(10 Marks)
MSE: 30 Marks written examination based on 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

1. Arjun Panesar, "Machine Learning and AI for Healthcare", A Press.
2. Arvin Agah, "Medical applications of Artificial Systems ", CRC Press

Reference Books:

1. Erik R. Ranschaert Sergey Morozov Paul R. Algra, "Artificial Intelligence in medical Imaging- Opportunities, Applications and Risks", Springer
2. Sergio Consoli Diego Reforgiato Recupero Milan Petković,"Data Science for Healthcare Methodologies and Applications", Springer
3. Dac-Nhuong Le, Chung Van Le, Jolanda G. Tromp, Gia Nhu Nguyen, "Emerging technologies for health and medicine", Wiley.
4. Ton J. Cleophas , Aeilko H. Zwinderman, "Machine Learning in Medicine- Complete Overview", Springer

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDO7013	Neural Networks and Fuzzy Systems	L	T	P	L	T	P	Total
		3	--		3	--		3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage		100

Pre-requisite Course Codes	Engineering Mathematics, Data Structures and Algorithm, Python Programming(CSC301,CSC401,CSC303,CSC402,CSL405)
Course Outcomes	CO1 Acquire basic knowledge of fuzzy set theory properties and relations.
	CO2 Implement Fuzzy operations towards Fuzzy-rule creations
	CO3 Gain familiarity with the training and implementation of Associative Memory Network.
	CO4 Understand the architecture and basics components of Unsupervised learning networks.
	CO5 Analyze the significance and working of the special Networks.
	CO6 Interpret Hybrid System to analyze the Principles of Soft computing in Neuro-Fuzzy applications.

Module No.	Unit No.	Topics	Ref	Hrs.
1		**Fuzzy Set Theory**	2	7
	1.1	Introduction to soft and hard computing Fuzzy Sets: Basic definition and terminology of fuzzy sets, Classic set operations; Fuzzy set operations- Union, Intersection, complement, Difference; Properties of fuzzy sets.		
	1.2	Fuzzy relations: Cartesian product of relation, Classica Relation, Cardinality of fuzzy relations, Operations on Fuzzy relations, Properties of Fuzzy relations, Fuzzy composition, Tolerance and Equivalence Relationship.		
	1.3	Membership Functions: Features of Membership Functions, Fuzzification, Methods of membership value assignments.		
2		**Fuzzy Rules, Reasoning, and Inference System**	2	8
	2.1	Defuzzification: Lambda-Cuts for Fuzzy Sets; Lambda-Cuts for Fuzzy Relations; Defuzzification methods: Max-Membership Principles, Centroid Method, Weighted Average Method, Mean-Max Membership, Center of Sums, Center of Largest Area, First of Maxima		
	2.2	Fuzzy Arithmetic and Rules: Fuzzy arithmetic, Fuzzy measures, Measures of Fuzziness, Truth Value and Tables in Fuzzy Logic, Fuzzy Propositions, Formation of rules, Decomposition of rules, Fuzzy Reasoning.		

	2.3	Fuzzy Inference System (FIS): Mamdani FIS, Sugeno FIS, Comparison between Mamdani and Sugeno FIS		
3		**Associative Memory Networks**	1,3	6
	3.1	Introduction: Basics of associative memory networks, Training algorithms for Pattern Association		
	3.2	Types of Networks: Radial basis function network : architecture training algorithm, Auto-associative Memory Network – Architecture, Flowchart of training process, Training algorithm, Testing algorithm, Hetero-associative Memory Network- Architecture and Testing algorithm, Bidirectional Associative Memory(BAM) Network-Architecture, Discrete BAM, Continuous BAM.		
4		**Unsupervised Learning Networks**	1,3,4	8
	4.1	Introduction Fixed weight competitive nets, Maxnet, Maxican net, Hamming Network		
	4.2	Kohonen Self- Organizing Feature Maps: Basic concepts, Architecture, Flowchart, Algorithms, Kohonen Self-Organizing Motor map Training algorithm.		
	4.3	Adaptive resonance Theory: Architecture, Fundamental Operating principles, a Algorithms, Adaptive Resonance Theory I – Architecture, Flowchart of Training process, Training algorithm, Adaptive Resonance Theory 2 - Architecture, Algorithm, Flowchart, Training algorithm, Sample Values of Parameter.		
5		**Special Network**	4,5	5
	5.1	Introduction: Boltzmann Machine, Gaussian Machine, Probabilistic neural nets Spatio-Temporal connection network model, Ensemble neural model Extreme learning machine models, Online, Pruned, Improved Application of ELM		
6		**Hybrid Computing**	2	5
	6.1	Neuro-Fuzzy Hybrid Systems: Introduction to Neuro-Fuzzy systems, Comparison of Fuzzysystems and Neural networks, Characteristics of Neuro-Fuzzy systems, Classification of Neuro-Fuzzy systems. Introduction to Adaptive Neuro-Fuzzy Inference System (ANIFS), ANFS Architecture, Constraints of ANFIS, ANFIS as a Universal Approximator		
			Total	39

Course Assessment:

ISE-1: Quiz (10 Marks)

Activity: Assignment (10 Marks)

ISE-2: Quiz (10 Marks)

Activity: Assignment (10 Marks)

MSE: 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

1. S.N. Sivanandan and S.N. Deepa, Principles of Soft Computing, Wiley India, 2007, ISBN: 10: 81- 265-1075-7.
2. J.-S. R. Jang, C. –T. Sun, E. Mizutani, Neuro-Fuzzy and Soft Computing, A Computational Approach to Learning and Machine Intelligence, PHI Learning Private Limited-2014
3. Neural Networks: A Classroom Approach, Satish Kumar, Tata McGraw-Hill Education 2004/2007
4. Simon Haykin, Neural Networks A Comprehensive Foundation, Second Edition, Pearson Education-2004
5. David E. Goldberg, Genetic Algorithms, in search, optimization and Machine Learning, Pearson

Reference Books:

1. Anupam Shukla, Ritu Tiwari, Rahul Kala, Real Life Applications of Soft Computing, CRC Press, Taylor & Francis Group, 2010.
2. Genetic Algorithms and Genetic Programming Modern Concepts and Practical Applications © 2009 Michael Affenzeller, Stephan Winkler, Stefan Wagner, and Andreas Beham, CRC Press
3. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDO7021	User Experience Design with VR	L	T	P	L	T	P	Total
		3	--		3	--		3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		Web Technologies; Software Engineering(CSC502 ,CSC603)
Course Outcomes	CO1	Apply principles of user experience
	CO2	Apply emerging and established technologies to enhance User Experience design
	CO3	To create interface for international standards with ethics
	CO4	To evaluate user experience.
	CO5	Describe how VR systems work and list the applications of VR
	CO6	Design and implementation of the hardware that enables VR systems to be built

Module No.	Unit No.	Topics	Ref	Hrs.
1		**Introduction**	1	4
	1.1	Introduction to interface design, Understanding and conceptualizing Interface, understanding user's conceptual cognition, Core Elements of User Experience, Working of UX elements		
2		**The UX Design Process – Understanding Users & Structure:**	3	8
	2.1	Defining the UX, Design Process and Methodology, Understanding user requirements and goals, Understanding the Business Requirements/Goals, User research, mental models, wireframes, prototyping, usability testing.		
	2.2	Visual Design Principles , Information Design and Data Visualization Interaction Design, UI Elements and Widgets, Screen Design and Layouts		
3		**UX Design Process: Prototype and Test**	2	6
	3.1	Testing your Design, Usability Testing, Types of Usability Testing , Usability Testing Process, Preparing and planning for the Usability Tests		
	3.2	Prototype your Design to Test, Introduction of prototyping tools, conducting Usability Test, communicating Usability Test Results		
4		**UX Design Process: Iterate/ Improve and Deliver**	3	5
	4.1	Understanding the Usability Test, findings, Applying the Usability Test, feedback in improving the design.		

	4.2	Communication with implementation team. UX Deliverables to be given to implementation team		
5		**Introduction to Virtual Reality**	2	8
	5.1	Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality		
	5.2	Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR		
6		**Applying Virtual Reality**	2	8
	6.1	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		
			Total	39

Course Assessment:

ISE-1: Quiz (10 Marks)
Activity: Assignment (10 Marks)
ISE-2: Quiz (10 Marks)
Activity: Assignment (10 Marks)
MSE: 30 Marks written examination based on 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

1. Interaction Design, Beyond Human Computer Interaction, Rogers, Sharp, Preece Wiley India Pvt Ltd.
2. The essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin
3. Designing The user Interface by Shneiderman, Plaisant, Cohen, Jacobs Pearson

Reference Books:

1. The Elements of User Experience by Jesse James Garrett
2. Don't make me think, by Steve Krug
3. Observing the User Experience: A Practitioner's Guide to User Research by Mike Kuniavsky

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDO7022	Blockchain Technologies	L	T	P	L	T	P	Total
		3	--		3	--		3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		Cryptography and Distributes systems(CSC602 CSDLO6012)
Course Outcomes	CO1	Describe the basic concept of Blockchain and Distributed Ledger Technology.
	CO2	Interpret the knowledge of the Bitcoin network, nodes, keys, wallets and transactions
	CO3	Implement smart contracts in Ethereum using different development frameworks.
	CO4	Develop applications in permissioned Hyperledger Fabric network.
	CO5	Interpret different Crypto assets and Crypto currencies
	CO6	Analyze the use of Blockchain with AI, IoT and Cyber Security using case studies

Module No.	Unit No.	Topics	Ref	Hrs.
1		**Introduction to Blockchain**	1	5
	1.1	Distributed Ledger Technologies: Introduction to blockchain: History, evolution, fundamentals concepts, components, types. Block in a Blockchain: Structure of a Block, Block Header Hash and Block Height, The Genesis Block, Linking Blocks in the Blockchain, Merkle Tree		
2		**Consensus Protocol and Bitcoin blockchain**	1	6
	2.1	Consensus: Byzantine Generals Problem, consensus algorithms: PoW, PoS, PoET, PoA, LPoS, pBFT, Proof-of-Burn (PoB), Life of a miner, Mining difficulty, Mining pool and its methods.		
	2.2	Bitcoin: What is Bitcoin, history of Bitcoin, Bitcoin Common terminologies: keys, addresses and nodes, Bitcoin mining, hashcash, Block propagation and relay, bitcoin scripts, transactions in the bitcoin network.		
3		**Ethereum and Smart Contracts**	1,5	8
	3.1	Ethereum: History, Components, Architecture of Ethereum, Consensus, Miner and mining node, Ethereum virtual machine, Ether, Gas, Transactions, Accounts, Patricia Merkle Tree, Swarm, Whisper and IPFS, complete transaction working and steps in Ethereum, Case study of Ganache for Ethereum blockchain. Exploring etherscan.io and ether block structure, Comparison between Bitcoin and Ethereum		

	3.2	Smart Contracts: history, characteristics, working of smart contracts, types, Oracles, Structure & Limitations. Solidity programming: set-up tools and installation, Basics, functions, Visibility and Activity Qualifiers, Ethereum networks, solidity compiler, solidity files and structure of contracts, data types, storages, array, functions, Developing and executing smart contracts in Ethereum. Smart Contracts Use cases, Opportunities and Risk		
4		**Private and Consortium blockchains**	3,5	9
	4.1	Introduction to Private Blockchain: Key characteristics, need, Examples of Private and Consortium blockchains, Smart contracts in private blockchain.		
	4.2	Introduction to Hyperledger, Tools and Frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & Other Technologies. Hyperledger Platform, Paxos and Raft consensus, Ripple and Corda blockchains, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT.		
5		**Cryptocurrencies and digital tokens**	4	6
	5.1	Cryptocurrency basics, types, usage, ERC20 and ERC721 Tokens, comparison between ERC20 & ERC721, ICO: basics and related terms, launching an ICO, pros and cons, evolution and platforms, STO, Different Crypto currencies, Defi, Metaverse, Types of cryptocurrencies. Bitcoin, Altcoin, and Tokens (Utility and Security), Cryptocurrency wallets: Hot and cold wallets, Cryptocurrency usage, Transactions in Blockchain, UTXO and double spending problem		
6		**Blockchain applications, Tools and case studies**	1,2	5
	6.1	Applications of Blockchain: Various domains including Education, Energy, Healthcare, real-estate, logistics, supply chain. Tools: Corda, Ripple, Quorum and other Emerging Blockchain Platforms, Case Study on any of the Blockchain Platforms.		
			Total	39

Course Assessment:

ISE-1: Quiz (10 Marks)
Activity: Assignment (10 Marks)
ISE-2: Quiz (10 Marks)
Activity: Assignment (10 Marks)
MSE: 30 Marks written examination based on 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

1. Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhilash K. A and Meena Karthikeyan, Universities press.

2. Solidity Programming Essentials: A beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Ritesh Modi, Packt publication
3. Hyperledger Fabric In-Depth: Learn, Build and Deploy Blockchain Applications Using Hyperledger Fabric, Ashwani Kumar, BPB publications
4. Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond, Chris Burniske & Jack Tatar.
5. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.

Reference Books:

1. Mastering Bitcoin, programming the open Blockchain, 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491954386.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3. Blockchain Technology: Concepts and Applications, Kumar Saurabh and Ashutosh Saxena, Wiley Publication
4. The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and theTechnology that Powers Them, Antony Lewis. for Ethereum and Blockchain, Ritesh Modi, Packt publication. University of Mumbai, B. E. (Information Technology), Rev 2016 276.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDO7023	Game Theory for Data Science	L	T	P	L	T	P	Total
		3	--		3	--		3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		Probability Algebra(CSC301,CSC401)
Course Outcomes	CO1	Analyze and Discuss the notion of a strategic game and equilibria and identify the characteristics of main applications of these concepts.
	CO2	Discuss the use of Nash Equilibrium for other problems. Identify key strategic aspects and based on these be able to connect them to appropriate game theoretic concepts given a real world situation.
	CO3	Identify some applications that need aspects of Bayesian Games. Implement a typical Virtual Business scenario using Game theory
	CO4	Identify and discuss working principle of Non-Cooperative Games
	CO5	Discuss the Mechanism for Design Aggregating Preferences
	CO6	Identify and discuss working principle : Repeated Games

Module No.	Unit No.	Topics	Ref	Hrs.
1		**Introduction:**	1,2	6
	1.1	Making rational choices: basics of Games – strategy –preferences – payoffs – Mathematical basics – Game theory – Rational Choice – Basic solution concepts-non-cooperative versus cooperative games – Basic computational issues – finding equilibria and learning in gamesTypical application areas for game theory (e.g. Google's sponsored search, eBay auctions, electricity trading markets)		
2		**Games with Perfect Information:**	1,2	7
	2.1	Strategic games – prisoner's dilemma, matching pennies -Nash equilibria – theory and illustrations – Cournot and Bertrand models of oligopoly – auctions – mixed strategy equilibrium – zero-sum games – Extensive Games with Perfect Information – repeated games (prisoner's dilemma) – subgame perfect Nash equilibrium; computational issues		
3		**Games with Imperfect Information:**	1	6
	3.1	Games with Imperfect Information – Bayesian Games – Motivational examples – General Definitions – Information aspects – Illustrations – Extensive Games with Imperfect –Information – Strategies – Nash Equilibrium – Beliefs and sequential equilibrium – Illustrations – Repeated Games – The Prisoner's Dilemma – Bargaining.		
4		**Non-Cooperative Game Theory:**	2	7

	4.1	Non-cooperative Game Theory – Self-interested agents –Games in normal form – Analyzing games: from optimality to equilibrium – Computing Solution Concepts of Normal – Form Games – Computing Nash equilibria of two-player, zero-sum games – Computing Nash equilibria of two-player, general sum games – Identifying dominated strategies		
5		**Mechanism Design Aggregating Preferences:**	1,2	7
	5.1	Social Choice – Formal Model – Voting – Existence of social functions – Ranking systems – Protocols for Strategic Agents: Mechanism Design – Mechanism design with unrestricted preferences – Efficient mechanisms – Vickrey and VCG mechanisms (shortest paths) – Combinatorial auctions – profit maximization Computational applications of mechanism design – applications in Computer Science –Google's sponsored search – eBay auctions – K-armed bandits		
6		**Repeated Games**	1,2	6
	6.1	Repeated games: The Prisoner's Dilemma , The main idea ,Preferences ,Infinitely repeated games, Strategies ,Some Nash equilibria of the infinitely repeated Prisoner's Dilemma , Nash equilibrium payoffs of the infinitely repeated Prisoner's Dilemma when the players are patient ,Subgame perfect equilibria and the one-deviation property		
			Total	39

Course Assessment:

Theory:

ISE-1: Quiz (10 Marks)
Activity: Assignment (10 Marks)

ISE-2: Quiz (10 Marks)
Activity: Assignment (10 Marks)

MSE: 30 Marks written examination based on 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

1. An Introduction to Game Theory by Martin J. Osborne
2. M. J. Osborne, An Introduction to Game Theory. Oxford University Press, 2004

Reference Books:

1. M. Machler, E. Solan, S. Zamir, Game Theory, Cambridge University Press, 2013.
2. N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani (Editors), Algorithmic Game Theory. Cambridge University Press, 2007.
3. A.Dixit and S. Skeath, Games of Strategy, Second Edition. W W Norton & Co Inc,2004.
4. YoavShoham, Kevin Leyton-Brown, Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Cambridge University Press 2008.
5. Zhu Han, DusitNiyato, WalidSaad, TamerBasar and Are Hjorungnes, "Game Theory in Wireless and Communication Networks", Cambridge University Press, 2012.
6. Y.Narahari, "Game Theory and Mechanism Design", IISC Press, World Scientific

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSL701	Deep Learning Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Python Programming, Engineering Mathematics (CSL405, CSC301, CSC401)
Course Outcomes	CO1	Implement basic neural network models.
	CO2	Design and train feedforward neural networks using various learning algorithms and optimize model performance.
	CO3	Build and train deep learning models such as Auto encoders, CNNs, RNN, LSTM,GRU etc.

Sr. No.	Suggested list of Experiment
	Based on Module 1 using Virtual Lab
1	Implement Multilayer Perceptron algorithm to simulate XOR gate.
2	To explore python libraries for deep learning e.g. Theano, TensorFlow etc.
	Module 2 (Any Two)
3	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.
	Module 3 (Any One)
6	Design the architecture and implement the autoencoder model for Image Compression.
7	Design the architecture and implement the autoencoder model for Image denoising.
	Module 4 (Any One)
8	Design and implement a CNN model for digit recognition application.
9	Design and implement a CNN model for image classification.
	Module 5 (Any Two)
10	Design and implement LSTM model for handwriting recognition, speech recognition, machine translation, speech activity detection, robot control, video games, time series forecasting etc.

11	Design and implement GRU for any real life applications, chat bots etc.
12	Design and implement RNN for classification of temporal data , sequence to sequence data modeling etc.

Course Assessment

ISE-1: Experiments 1 to 5 (20 Marks)

ISE-2: Experiments 5 to 10 (20 Marks)

Activity: Completion of Deep Learning Onramp MatLab course(10 Marks)

Text Books:

1. Ian Goodfellow, YoshuaBengio, 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 House5
5. M. J. Kochenderfer, Tim A. Wheeler. ―Algorithms for Optimization, MIT Press.

References:

1. Deep Learning from Scratch: Building with Python from First Principles- Seth Weidmanby O`Reilley
2. François Chollet. Deep learning with Python (Vol. 361). 2018 New York: Manning.
3. DouweOsinga. ―Deep Learning Cookbook, O'REILLY, SPD Publishers, Delhi.4
4. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall
5. International, Inc
6. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India

Online References:

1. https://keras.io/
2. https://stanford.edu/~shervine/teaching/cs-230/cheatsheet-recurrent-neural-networks
3. https://keras.io/examples/vision/autoencoder/
4. https://stanford.edu/~shervine/teaching/cs-230/cheatsheet-convolutional-neural-networks

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSL702	Big Data Analytics Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Java/Python(CSL305,CSL405)
Course Outcomes	CO1	Understand the key issues in big data management and its associated applications for business decisions and strategy.
	CO2	Develop problem solving and critical thinking skills in fundamental enabling techniques like Hadoop, Map reduce and NoSQL in big data analytics.
	CO3	Collect, manage, store, query and analyze various forms of Big Data.
	CO4	Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
	CO5	Adapt adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.
	CO6	Solve Complex real world problems in various applications like recommender systems, social media applications, health and medical systems, etc.

Sr. No.	Suggested list of Experiment
1	Hadoop HDFS Practical: -HDFS Basics, Hadoop Ecosystem Tools Overview. -Installing Hadoop. -Copying File to Hadoop. -Copy from Hadoop File system and deleting files. -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 eco system component Sqoop.
3	To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands.
4	Experiment on Hadoop Map-Reduce / PySpark: -Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc. Scilab/ Tableau/ Rapid miner.
5	Create HIVE Database and Descriptive analytics-basic statistics, visualization using Hive/PIG/R.
6	Write a program to implement word count programs using MapReduce.
7	Implementing DGIM algorithm using any Programming Language/ Implement Bloom Filter using any programming language.
8	Implementing any one Clustering algorithm (K-Means/CURE) using Map-Reduce.
9	Streaming data analysis – use flume for data capture, HIVE/PYSpark for analysis of twitter data, chat data, weblog analysis etc.
10	Implement PageRank using Map-Reduce.

11	Implement predictive Analytics techniques (regression / time series, etc.) using R/Scilab/ Tableau/ Rapid miner.

Course Assessment

ISE-1: Experiments 1 to 4 (10 Marks)
Activity: Mini project Design (10 Marks)
ISE-2: Experiments 5 to 8 (10 Marks)
Activity: Mini Project (20 Marks)

Useful Links

1. https://nptel.ac.in/courses/117/102/117102062/
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=305
3. https://nptel.ac.in/courses/106/106/106106167/

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDOL7011	Natural Language Processing Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	10	--	15	--	25	

Pre-requisite Course Codes		Java/Python(CSL305,CSL405)
Course Outcomes	CO1	Apply various pre-processing techniques to given text data
	CO2	Implement language model to do word level analysis for any sentence
	CO3	Get grammatical structure details of English or Hindi language statement
	CO4	Realize semantics and pragmatic analysis of text data
	CO5	To design and implement appropriate NLP technique required for any real-world NLP based system

Sr. No.	Suggested list of 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 text preprocessing techniques for any given text: Tokenization and Filtration & Script Validation
3	Apply various other text preprocessing techniques for any given text: Stop Word Removal, Lemmatization / Stemming.
4	Perform morphological analysis and word generation for any given text.
5	Implement N-Gram model for the given text input.
6	Study the different POS taggers and Perform POS tagging on the given text.
7	Perform chunking by analyzing the importance of selecting proper features for training a model and size of training
8	Implement Named Entity Recognizer for the given text input.
9	Implement Text Similarity Recognizer for the chosen text documents
10	Implement word sense disambiguation using LSTM/GRU
11	Exploratory data analysis of a given text (Word Cloud)
12	Mini Project Report: For any one chosen real world NLP application
13	Implementation and Presentation of Mini Project

Course Assessment

ISE-1: Experiments 1 to 4 (10 Marks)

ISE-2: Experiments 5 to 8 (10 Marks)
Activity: Mini Project (5 Marks)

Useful Links

1. https://nlp-iiith.vlabs.ac.in/List%20of%20experiments.html
2. https://onlinecourses.nptel.ac.in/noc21_cs102/preview
3. https://onlinecourses.nptel.ac.in/noc20_cs87/preview
4. https://nptel.ac.in/courses/106105158

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDOL7012	AI for Healthcare Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	10	--	15	--	25	

Pre-requisite Course Codes		Python(CSL405)
Course Outcomes	CO1	Understand computational models of AI
	CO2	Develop healthcare applications using appropriate computational tools.
	CO3	Apply appropriate models to solve specific healthcare problems.
	CO4	Analyze and justify the performance of specific models as applied to healthcare problems.
	CO5	Design and implement AI based healthcare applications.

Sr. No.	Suggested list of Experiment
1	Collect, Clean, Integrate and Transform Healthcare Data based on specific disease.
2	Perform Exploratory data analysis of Healthcare Data.
3	AI for medical diagnosis based on MRI/X-ray data.
4	AI for medical prognosis.
5	Natural language Entity Extraction from medical reports.
6	Predict disease risk from Patient data.
7	Medical Reviews Analysis from social media data.
8	Explainable AI in healthcare for model interpretation.
9	Mini Project-Design and implement innovative web/mobile based AI applications using Healthcare Data. (this needs to be implemented in group of 3-4 students)
10	Documentation and Presentation of Mini Project.

Course Assessment

ISE-1: Experiments 1 to 4 (10 Marks)
ISE-2: Experiments 5 to 8 (10 Marks)
Activity: Mini Project (5 Marks)

Textbooks:

1. Arjun Panesar, "Machine Learning and AI for Healthcare", A Press.
2. Arvin Agah, "Medical applications of Artificial Systems ", CRC Press

References:

1. Erik R. Ranschaert Sergey Morozov Paul R. Algra, "Artificial Intelligence in medicalImaging- Opportunities, Applications and Risks", Springer
2. Sergio Consoli Diego ReforgiatoRecupero Milan Petković,"Data Science for Healthcare-Methodologies and Applications", Springer
3. Dac-Nhuong Le, Chung Van Le, Jolanda G. Tromp, Gia Nhu Nguyen, "Emerging technologies for health and medicine", Wiley.
4. Ton J. Cleophas, Aeilko H. Zwinderman, "Machine Learning in Medicine-CompleteOverview", Springer

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDOL7013	Neural Networks and Fuzzy Systems Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	10	--	15	--	25	

Pre-requisite Course Codes		C/C++/Java/MATLAB
Course Outcomes	CO1	Implement Fuzzy operations and functions towards Fuzzy-rule creations.
	CO2	Build and training Associative Memory Network
	CO3	Build Unsupervised learning based networks .
	CO4	Design and implement architecture of Special Networks

Sr. No.	Suggested list of Experiment
1	Demonstrate Union and intersection of two Fuzzy Sets.
2	Demonstrate difference between two Fuzzy Sets.
3	Implement Fuzzy membership functions
4	Implement Fuzzy Inference system (FIS).
6	Implement any Defuzzification of membership methods.
7	Implement Bidirectional Associative Memory(BAM) Network
8	Implement Radial basis function network.
9	Implement Basic Neural Network learning rules.
10	Implement any Unsupervised Learning algorithm.10 Implement Kohonen Self-Organizing Feature Maps.
11	Implement a Probabilistic Neural Network.
12	Implement any Ensemble neural model.
13	Design any one Neuro-Fuzzy system.

Course Assessment

ISE-1: Experiments 1 to 4 (10 Marks)
ISE-2: Experiments 5 to 8 (10 Marks)
Activity: Mini Project (5 Marks)

Useful Links

1. https://onlinecourses.nptel.ac.in/noc21_ge07/preview
2. http://www.nitttrc.edu.in/nptel/courses/video/127105006/L25.html
3. https://archive.nptel.ac.in/courses/108/104/108104157

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDOL7021	User Experience Design with VR Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	10	--	15	--	25	

Pre-requisite Course Codes		Computer Graphics, Python(CSC305,CSL404)
Course Outcomes	CO1	Setup VR development environment
	CO2	Use HTC Vive/ Google Cardboard/ Google Daydream and Samsung gear VR.
	CO3	Develop VR scene and place object
	CO4	Identify, examine and develop software that reflects fundamental techniques for the design and deployment of VR experiences

Sr. No.	Suggested list of 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 color 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 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	**C**reate an immersive environment (living room/ battlefield/ tennis court) with only static game objects. 3D game objects can be created using Blender or use available 3D models
8	Include animation and interaction in the immersive environment created in experiment 7
9	**C**ase Study/Mini Project: Create a virtual environment for any use case. The application must include at least 4 scenes which can be changed dynamically, a good UI, animation and interaction with game objects. (e.g. VR application to visit a zoo)
10	Presentation of Mini Project

Course Assessment

ISE-1: Experiments 1 to 4 (10 Marks)

ISE-2: Experiments 5 to 8 (10 Marks)

Activity: Mini Project (5 Marks)

Useful Links

1. https://nptel.ac.in/courses/106106138
2. https://nptel.ac.in/courses/121106013
3. https://www.coursera.org/learn/develop-augmented-virtual-mixed-extended-reality-applications-webxr-unity-unreal
4. https://tih.iitr.ac.in/AR-VR.html

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDOL7022	Blockchain Technologies Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	10	--	15	--	25	

Pre-requisite Course Codes		Java, Python, JavaScript.(CSL304,CSL404.CSC502)
Course Outcomes	CO1	Develop and test smart contract on local Blockchain.
	CO2	Develop and test smart contract on Ethereum test networks.
	CO3	Write and deploy smart contract using Remix IDE and Metamask.
	CO4	Design and develop Cryptocurrency.
	CO5	Write and deploy chain code in Hyperledger Fabric.
	CO6	Develop and test a Full-fledged DApp using Ethereum/Hyperledger.

Sr. No.	Suggested list of Experiment
1	Local Blockchain: Introduction to Truffle, establishing local Blockchain using Truffle a) Cryptography in Blockchain and Merkle root tree hash
2	Smart contracts and Chain code: Solidity programming language, chain code (Java/JavaScript/Go), deployment on Truffle local a) Creating Smart Contract using Solidity b) Embedding wallet and transaction using Solidity
3	Deployment and publishing smart contracts on Ethereum test network: Ethereum Test networks (Ropsten/Gorelli/Rinkeby), deployment on test networks, Web3.js/Web3.py for interaction with Ethereum smart contract a) Blockchain platform ethereum using Geth. b) Blockchain platform Ganache
4	Remix IDE and Metamask: Smart contract development and deployment using Metamask and Remix. Design and develop Crypto currency
5	Chain code deployment in Hyperledger Fabric: Chain code deployment in Hyperledger fabric Mini project: Study required front end tools
6	Case Study on Hyperledger
7	Case Study on Other Blockchain platforms.
8	Creating a blockchain Application
9	Mini-project on Design and Development of a DApps using Ethereum/Hyperledger Fabric: Implementation of Mini Project, 1. Design, configure and testing of mini project 2. Report submission as per guidelines 3. Implementation and Presentation of Mini Projects

Course Assessment

ISE-1: Experiments 1 to 4 (10 Marks)
ISE-2: Experiments 5 to 8 (10 Marks)
Activity: Mini Project (5 Marks)

Text Books:

1. Ethereum Smart Contract Development, Mayukh Mukhopadhyay, Packt publication.
2. Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereumand Blockchain, Ritesh Modi, Packt publication.
3. Hands-on Smart Contract Development with Hyperledger Fabric V2, Matt Zand, Xun WuandMark Anthony Morris, O'Reilly.

Reference Books:

1. Mastering Blockchain, Imran Bashir, Packt Publishing
2. Introducing Ethereum and Solidity, Chris Dannen, APress.
3. Hands-on Blockchain with Hyperledger, Nitin Gaur, Packt Publishing.

Mini project:

1. Students should carry out mini-project in a group of three/four students with a subject In-charge
2. The group should meet with the concerned faculty during laboratory hours and the progress of work discussed must be documented.
3. Each group should perform a detailed literature survey and formulate a problem statement.
4. Each group will identify the hardware and software requirement for their defined mini project problem statement.
5. Design, develop and test their smart contract/chain code.
6. Each group may present their work in various project competitions and paper presentations

Documentation of the Mini Project

The Mini Project Report can be made on following lines:

1. Abstract
2. Contents
3. List of figures and tables
4. Chapter-1 (Introduction, Literature survey, Problem definition, Objectives, Proposed
5. Solution, Technology/platform used)
6. Chapter-2 (System design/Block diagram, Flow chart, Software requirements, cost
7. estimation)
8. Chapter-3 (Implementation snapshots/figures with explanation, code, future directions)
9. Chapter-4 (Conclusion)
10. References

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDOL7023	Game Theory for Data Science Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	10	--	15	--	25	

Pre-requisite Course Codes		Probability, Algebra(CSC301,CSC401)
Course Outcomes	CO1	Gain a solid understanding of fundamental game theory concepts
	CO2	Develop the ability to apply game theory principles to real-world data science problems..
	CO3	Analyze and identify Nash equilibria in various game scenarios.
	CO4	Comprehend the implications and applications of mixed strategies in game theory.
	CO5	Acquire practical skills in utilizing game theory algorithms and computational tools
	CO6	Explore and appreciate the wide range of applications of game theory in data science

Sr. No	Suggested list of Experiment
1	Prisoners dilemma
2	Pure Strategy Nash Equilibrium
3	Extensive Form – Graphs and Trees, Game Trees
4	Strategic Form – Elimination of dominant strategy
5	Minimax theorem, minimax strategies
6	Perfect information games: trees, players assigned to nodes, payoffs, backward Induction, subgame perfect equilibrium
7	Imperfect-information games – Mixed Strategy Nash Equilibrium – Finding mixed-strategy Nash equilibria for zero sum games, mixed versus behavioral strategies
8	Repeated Games
9	Bayesian Nash equilibrium
10	Implementation of any game for example Tic Tac To , coloring triangle , water jug , 8 queen , 8 puzzle etc (this should be done in group of 3-4)

Course Assessment

ISE-1: Experiments 1 to 4 (10 Marks)
ISE-2: Experiments 5 to 8 (10 Marks)
Activity: Mini Project (5 Marks)

Textbooks:

1. An Introduction to Game Theory by Martin J. Osborne
2. M. J. Osborne, An Introduction to Game Theory. Oxford University Press, 2004.

References:

1. M. Machler, E. Solan, S. Zamir, Game Theory, Cambridge University Press, 2013.

2. N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani (Editors), Algorithmic GameTheory. Cambridge University Press, 2007.
3. A.Dixit and S. Skeath, Games of Strategy, Second Edition. W W Norton & Co Inc,2004.
4. YoavShoham, Kevin Leyton-Brown, Multiagent Systems: Algorithmic,Game-Theoretic, and Logical Foundations, Cambridge University Press 2008.
5. Zhu Han, DusitNiyato, WalidSaad, TamerBasar and Are Hjorungnes, "Game Theoryin Wireless and Communication Networks", Cambridge University Press, 2012.
6. Y.Narahari, "Game Theory and Mechanism Design", IISC Press, World Scientific.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO7011	Product Life Cycle Management	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
	CO2	Illustrate various approaches and techniques for designing and developing products.
	CO3	Apply Product Engineering Guidelines/ thumb rules in designing products for molding, machining, sheet metal working etc.
	CO4	Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module No.	Topics	Ref.	Hrs.
1	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management(PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy ,Change management for PLM	1,2	10
2.	**Product Design** : Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post Design Planning Phase, 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, 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	2	9
3	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	1,2	5
4.	**Virtual Product Development Tools :** For components, machines,	1	5

	and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital Mock-up, Model Building, Model analysis, Modeling and simulations in Product Design, Examples/ Case studies		
5.	**Integration of Environmental Aspects in Product Design** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	1,2	5
6	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	3	5
		Total	39

Course Assessment:

ISE-1:

Assignments for 10 Marks

Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2:

Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. John Stark,"Product Life cycle Management: Paradigm for 21st Century Product Realization", Springer- Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice,Guido La Rosa,AntoninoRisitano,"Product Design For The Environment-A Lifecycle approach", Taylor & Francis 2006, ISBN:0849327229
3. Antti, ImmonenAnselmi,"Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve,"Product Life cycle Management: Driving the next generation of lean thinking", Tata Mc Graw Hill, 2006 , ISBN: 0070636265

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO7012	Reliability Engineering	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Understand and apply the concept of Probability to engineering problems
	CO2	Apply various reliability concepts to calculate different reliability parameters
	CO3	Estimate the system reliability of simple and complex systems
	CO4	Carry out a Failure Mode Effect and Criticality Analysis

Module No.	Unit No.	Topics	Ref.	Hrs.
1.	1.1	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.	1,2	8
	1.2	**Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.		
	1.3	**Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis		
2	2.1	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, BathTub Curve.	1,2	8
	2.2	**Failure Data Analysis:** Hazardrate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.		
	2.3	**Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.		
3	3.1	**System Reliability:** System Configurations: Seri es, parallel, mixed configuration, k out of n structure, Complex systems.	1	5
4	4.1	**Reliability Improvement:** Redundancy Techniques: Element Redundancy, Unit Redundancy, And Standby Redundancies. Markov Analysis. System Reliability Analysis–Enumeration method, Cut-set method, Success Path method, Decomposition method.	2,3	8
5	5.1	**Maintainability and Availability** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Inter changeability, Modularization and	1,2	5

		Accessibility, Repair Vs Replacement. Availability–qualitative aspects.		
6	6.1	**Failure Mode, Effects and Criticality Analysis:** Failure Mode Effects Analysis, severity/ criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	3	5
			Total	**39**

Course Assessment:

ISE-1:

Assignments for 10 Marks

Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2:

Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. L.S.Srinath, "Reliability Engineering", Affiliated East-West Press (P) Ltd., 1985.
2. Charles E.Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S.Dhillon, C.Singh,"Engineering Reliability", John Wiley & Sons,1980.
4. P.D.T.Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson,"Reliability in Engineering Design", John Wiley& Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata Mc Graw-Hill Publishing Co. Ltd.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO7013	Management Information System	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Explain how information systems Transform Business
	CO2	Identify the impact information systems have on an organization
	CO3	Describe IT infrastructure and its components and its current trends
	CO4	Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
	CO5	Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module No.	Topics	Ref.	Hrs.
1	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	1	4
2.	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business Intelligence(BI): Managers and Decision Making, BI for Data analysis and Presenting Results	1,2	7
3	Ethical issues and Privacy: Information Security.Threat to IS, and Security Controls	1	7
4.	Social Computing (SC): Web2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytical CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	2	7
5.	Computer Networks Wired and Wireless Technology, Pervasive Computing, Cloud computing model.	3	6
6	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development lifecycle models.	1	8
		Total	39

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. Kelly Rainer, Brad Prince, Management Information Systems,Wiley
2. K.C. Laudon and J.P.Laudon, Management Information Systems: Managing The Digital Firm, 10thEd. Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, PrenticeHall, 2008

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO7014	Design of Experiments	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Plan data collection, to turn data into information and to make decisions that lead to appropriate action
	CO2	Apply the methods taught to real life situations
	CO3	Plan, analyze, and interpret the results of experiments

Module No.	Unit No.	Topics	Ref.	Hrs.
1.		**Introduction**	1	6
	1.1	Strategy of Experimentation Typical Applications of Experimental Design Guidelines for Designing Experiments Response Surface Methodology		
2.		**Fitting Regression Models**	1,2	8
	2.1	Linear Regression Models Estimation of the Parameters in Linear Regression Models Hypothesis Testing in Multiple Regression Confidence Intervals in Multiple Regression Prediction of new response observation Regression model diagnostics Testing for lack of fit		
3		**Two-Level Factorial Design**	1,2, 3,4	7
	3.1	The 2^2 Design The 2^3 Design The General 2^k Design A Single Replicate of the 2^k Design The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design Split-Plot Designs The Design		
4.		**Two-Level Fractional Factorial Design**	1,2, 3	7
	4.1	The One-Half Fraction of the 2^k Design The One-Quarter Fraction of the 2^k Design The General 2^{k-p} Fractional Factorial Design Resolution III Designs Resolution IV and V Designs Fractional Factorial Split-Plot Designs		
5.		**Response Surface Methods and Designs**	1,2	7
	5.1	Introduction to Response Surface Methodology The Method of Steepest Ascent Analysis of a Second-Order Response Surface Experimental Designs for Fitting Response Surfaces Testing Logistics		
6		**Taguchi Approach**	6	4
	6.1	Crossed Array Designs and Signal-to-Noise Ratios Analysis Methods Robust design examples		
			Total	**39**

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley& Sons, New York, 2001
2. D.C.Montgomery, Design And Analysis Of Experiments,5th edition, John Wiley & Sons, New York, 2001
3. George EPBox, JStuart Hunter, William G Hunter, Statistics for Experimenters: Design, Innovation And Discovery, 2ndEd. Wiley
4. WJ Diamond, Practical Experiment Designs for Engineers and Scientists, John Willy and SonsInc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer texts in Statistics), Springer by A.M. Dean, and D. T. Voss
6. Phillip J Ross,"Taguchi Techniques for Quality Engineering,"McGraw Hill
7. Madhav Phadke,"Quality Engineering using Robust Design,"Prentice Hall

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO7015	Operations Research	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
	CO2	Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
	CO3	Solve specialized linear programming problems like the transportation and assignment problems; solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
	CO4	Understand the applications of integer programming and queuing model and compute important performance measures

Module No.	Unit No.	Topics	Ref.	Hrs.
1.	1.1	**Introduction to Operations Research**: Introduction, Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method,Simplex Method Penalty Cost Method or BigM-method, Two Phase Method, Revised Simplex Method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complementary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's Approximation Method. Optimality Test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines And Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's Cutting Plane Algorithm, Branch and Bound Technique. Introduction to	1	14

		Decomposition algorithms.		
2.	2.1	**Queuing Models**: queuing systems structures, single server multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	1, 2	5
3	3.1	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts,Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Application of Simulation, Advantages of Simulation, Limitations of Simulation	1	5
4.	4.1	**Dynamic programming**.Characteristics of dynamic programming. Dynamic programming approach for Priority Management Employment Smoothening, capital budgeting, Stagecoach/ Shortest Path, cargo loading and Reliability problems	2	5
5.	5.1	**GameTheory**. Competitivegames, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2X2 games	1, 2	5
6	6.1	**Inventory Models**: Classical EOQModels, EOQModel with Price Breaks, EOQwith Shortage, Probabilistic EOQ Model,	2	5
			Total	**39**

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. Taha, H. A. "Operations Research- An Introduction",Prentice Hall, (7thEdition),2002.
2. Ravindran, A, Phillips, D. TandSolberg,J.J."Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F.S.andLiebermann, G.J."Introduction to Operations Research", Tata Mcgraw Hill, 2002.
4. Operations Research, S. D.Sharma, Kedar Nath Ram Nath- Meerut.
5. Operations Research, Kanti Swarup, P.K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO7016	Cyber Security and Laws	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Understand the concept of cyber crime and its effect on outside world
	CO2	Interpret and apply IT law in various legal issues
	CO3	Distinguish different aspects of cyber law
	CO4	Apply Information Security Standards compliance during software design and development

Module No.	Topics	Ref.	Hrs.
1.	**Introduction to Cyber crime** : Cyber crime definition and origins of the world, Cybercrime And Information security, Classifications Of Cyber Crime, Cybercrime And The Indian ITA2000, A Global Perspective On Cyber Crimes.	1	4
2.	**Cyber offenses & Cybercrime** : How criminal plan the attacks, Social Engg, Cyberstalking, Cybercafé and Cybercrimes, Botnets, Attackvector, Cloud Computing, Proliferation of Mobile and Wireless Devices,Trends In Mobility, Credit Card Frauds Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/CellPhones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policy and Measure in Mobile Computing Era, Laptops	1,2	9
3	**Tools and Methods Used in Cyberline** : Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQLInjection, Buffer OverFlow, Attacks onWireless Networks, Phishing, Identity Theft (IDTheft)	1,2	6
4.	**The Concept of Cyberspace** : E-Commerce, The Contract Aspects In Cyber Law, The Security Aspect of Cyber Law , The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law ,The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking, The Need for an Indian Cyber Law	3	8
5.	**Indian IT Act. :** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, ITS Act. 2008 and its Amendments	1,2	6
6	**Information Security Standard compliances** : SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	1	6

Total	39

Course Assessment:

ISE-1: Assignments for 10 Marks

Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. Nina Godbole, SunitBelapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan ; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security,Wiley India, New Delhi
6. Kennetch J. Knapp, Cyber Security & Global Information AssuranceInformation Science Publishing.
7. William Stallings, Cryptography And Network Security, Pearson Publication
8. Websites For More Information Is Available On:The Information Technology ACT 2008-TIFR : https://www.tifrh.res.in
9. Website For More Information , A Compliance Primer for IT professional https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO7017	Disaster Management and Mitigation measures	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Get to know natural as well as man made disasters and their extent and possible effects on the economy.
	CO2	Plan of national importance structures based upon the previous history.
	CO3	Get acquainted with government policies, acts and various organizational structures associated with an emergency.
	CO4	Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module No.	Unit No.	Topics	Ref.	Hrs
1.	1.1	**Introduction: Definition** of Disaster, hazard, global and Indian scenario, and general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	1, 2	3
2.	2.1	**Natural Disaster:** Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion	2	9
	2.2	**ManMade Disasters:** Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of man made disasters.	1, 2	
3	3.1	**Disaster Management**: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm Shift in disaster management.	1	6
	3.2	**Policy and administration**: Importance and principles of disaster management policies, command and co-ordination of disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flow charts showing the entire process.	1, 2	

4.	4.1	**Institutional Framework for Disaster Management in India:** Importance Of Public Awareness, Preparation and Execution Of Emergency Management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National Disaster Management Authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up emergency facilities, importance of effective communication amongst different agencies in such situations.	3	6
	4.2	Use of Internet and software for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	2	
5.	5.1	**Financing Relief Measures:**Ways To Raise Finance For Relief Expenditure, role of government agencies and NGOs in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGOs and the works they have carried out in the past on the occurrence of various disasters,Ways To Approach these teams.	5, 6	9
	5.2	International relief aid agencies and their role in extreme events.		
6	6.1	**Preventive and Mitigation Measures:**Pre-disaster, during disaster and post-disaster measures in some events in general	1, 2	6
	6.2	Structural mapping: Risk Mapping, assessment analysis, seawalls and embankments, Bioshield, shelters, early warning and communication	2	
	6.3	Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education,contingency plans.	1, 3	
	6.4	Do's and don'ts in case of disasters and effective implementation of relief aids.	3	
			Total	**39**

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. 'Disaster Management' by HarshK.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India by.S.Dagur, publishedbyCentre for land warfare studies, NewDelhi, 2011.
3. 'Introduction toInternational Disaster Management' by By Damon Coppola, Butterworth Heinemann Elsevier Publications.
4. Disaster Management Handbook biJakPinkowski, CRCPress Taylor and Francis Group.
5. Disaster Management & rehabilitation Rajdeep Dasgupta, Mittal Publications, NewDelhi.

6. 'Natural Hazards and DisasterManagement,Vulnerability and Mitigation–RBSingh, Rawat Publications
7. Concepts and Techniques of GIS–C.P.Lo Albert, K.W.Yonng–PrenticeHall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic websites)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO 7018	Energy Audit and Management	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	To identify and describe the present state of energy security and its importance.
	CO2	To identify and describe the basic principles and methodologies adopted in energy audit of a utility.
	CO3	To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
	CO4	To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
	CO5	To analyze the data collected during performance evaluation and recommend energy saving measures

Module No.	Topics	Ref.	Hrs.
1.	**Energy Scenario :**Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	1	4
2.	**Energy Audit Principles** : Definition, Energy audit-need, Types of energy audit , Energy management (audit) approach- understanding energy costs, Benchmarking, Energy performance, Matching energy use to requirement, Maximizing System Efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring & targeting; Energy audit Instruments; Data And Information-analysis. Financial Analysis Techniques: Simple Payback Period, NPV, Return on investment (ROI), Internal rate of return (IRR)	2	8
3	**Energy Management and Energy Conservation in Electrical System** : Electricity Billing, Electrical load management and maximum demand Control Power Factor Improvement, Energy efficient equipment and appliances ,star ratings. Energy Efficiency Measures In Lighting System, Lighting Control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy Conservation Opportunities In: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	1,2	10
4.	**Energy Management and Energy Conservation in Thermal Systems** : Review Of Different Thermal Loads; Energy Conservation	3	10

	Opportunities In: Steam Distribution System, Assessment Of Steam Distribution Losses, Steam leakages, Steam Trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.		
5.	**Energy Performance Assessment** : On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	1,2	4
6	**Energy conservation in Buildings** : Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application Of Non-Conventional and Renewable Energy Sources	6	3
		Total	39

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. Handbook of Electrical Installation Practice,Geofry Stokes, Blackwell Science
2. Designing With Light: Lighting Handbook, ByAnilValia,LightingSystem
3. Enegy Management Handbook, By W.C. Turner, John Wileyand Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles,C.B.Smith,Pergamon Press
6. Energy Conservation Guidebook, Dale R.Patrick,S.Fardo, Ray E.Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W.J. Younger,T. Niehus, CRCPress
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO 7019	Development Engineering	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Demonstrate understanding of knowledge for Rural Development.
	CO2	Prepare solutions for Management Issues.
	CO3	Take up Initiatives and design Strategies to complete the task
	CO4	Develop acumen for higher education and research.
	CO5	Demonstrate the art of working in group of different nature
	CO6	Develop confidence to take up rural project activities independently

Module No.	Topics	Ref.	Hrs.
1.	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	1	8
2.	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	2	6
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development	1,2	7
4.	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	3	4

5.	Values and Science and Technology Material development and its values; the challenge ofscience and technology; Values in planning profession, research and education Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom	1,2	10
6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	8	4
		Total	39

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rdGoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSP701	Major Project – I	L	T	P	L	T	P	Total
			--	6		--	3	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	15	--	20	40	75	

Pre-requisite Course Codes		
Course Outcomes	CO1	Identify problems based on societal /research needs
	CO2	Apply Knowledge and skill to solve societal problems in a group
	CO3	Draw the proper inferences from available results through theoretical/ experimental/simulations
	CO4	Analyze the impact of solutions in societal and environmental context for sustainable development.
	CO5	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning
	CO6	Demonstrate project management principles during project work.

Guidelines for the project

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.
- Dataset selected for the project should be large and real time
- Students can certainly take ideas from anywhere, but be sure that they should evolve them in the 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. AI,ML, DL, NNFS, NLP based algorithms can be implemented
- 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 expert in the domain.
- Head of 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

Project Report Format:

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

- Abstract
- Introduction
- Literature Survey/ Existing system
- Limitation Existing system or research gap
- Problem Statement and Objective
- Proposed System
- Analysis/Framework/ Algorithm
- Design details
- Methodology (your approach to solve the problem) Proposed System
- Experimental Set up
- Details of Database or details about input to systems or selected data
- Performance Evaluation Parameters (for Validation)
- Software and Hardware Setup
- Implementation Plan for Next Semester
- Timeline Chart for Term1 and Term-II (Project Management tools can be used.)
- References

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 teamwork

Course Assessment:

ISE-1: Idea Presentation & Review of Literature(15 Marks)
ISE-2: Analysis, Design, Proof of Concept (20 Marks)
ESE: Project Exam (oral exam with presentation) (40 Marks)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSC801	Advanced Artificial Intelligence	L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100
		Lab	--	--	--	--		--

Pre-requisite Course Codes		Engineering Mathematics, Data Structures and Algorithm, Python Programming
Course Outcomes	CO1	Acquire basic knowledge of Probabilistic Models
	CO2	Analyze the working and architecture for Generative Networks.
	CO3	Interpret various components and various types of Auto encoders
	CO4	Understand various aspects of Transfer Learning.
	CO5	Apply ensemble learning techniques to real-world problems and demonstrate improved predictive performance
	CO6	Relate to the nascent technologies in the field of artificial intelligence.

Module No.	Unit No.	Topics	Ref	Hrs
1		**Generative and Probabilistic Models**	2	8
	1.1	**Introduction** Overview of generative models and their importance in AI, Fundamentals of Probability theory and generative modeling, Introduction to GANs, VAEs and other generative models. Significance of generative models, Challenges with generative models.		
	1.2	**Probabilistic Models** Gaussian Mixture Models (GMMs), Hidden Markov Models (HMMs), Bayesian Networks, Markov Random Field (MRFs), Probabilistic Graphical Model.		
2		**Generative Adversarial Network**	1	7
	2.1	**Basics of GAN:** Generative Adversarial Networks (GANs) architecture, The discriminator model and generator model, Architecture and Training GANs, Vanilla GAN Architecture. GAN variants and improvements (DCGAN, WGAN, Conditional GAN, Cycle GAN, Challenges- Training instability and model collapse, GAN applications in image synthesis and style transfer.		
3		**Variational Autoencoders**	1,3	7

	3.1	**Introduction** Basic components of Variational Autoencoders(VAEs), Architecture and training of VAEs the loss function, Latent space representation and inference, Applications of VAEs in image generation.		
	3.2	**Types of Autoencoders** Undercomplete autoencoders, Sparse autoencoders, Contractive autoencoders, Denoising autoencoders, Variational Autoencoders(for generative modelling)		
4		**Transfer Learning**	3	5
	4.1	**Introduction to transfer learning** Basic terminologies, pre-trained model and data sets, Feature extraction and fine tune transfer learning, Recent advancement in transfer learning: self- supervised learning and meta learning.		
5		**Ensemble learning**	5	6
	5.1	**Ensemble Classifiers**: Introduction to Ensemble Methods. Bagging and random forests, Boosting algorithms: AdaBoost Stacking and blending models, Extreme Gradient Boosting (XGBoost): XGBoost Regression and classification.		
6		**Nascent Technologies in AI**	4	6
	6.1	**Convergence of AI with Augmented / Virtual reality techniques for product and process development** Limitations of 2D Learning Environments, Evolution of virtual worlds and immersive technologies, Definition and concepts of Augmented Reality, Definition and concept of the Metaverse, Characteristics and components of the Metaverse, Challenges and opportunities in the Metaverse ecosystem, AI in the realm of emerging quantum computing paragms		
			Total	39

Course Assessment:

ISE-1: Quiz (10 Marks)
Activity: Assignment (10 Marks)
ISE-2: Game (10 Marks)
Activity: Presentation on AI in emerging technologies (10 Marks)
MSE: 30 Marks written examination based on initial 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

1. Foster, D., 2022. Generative deep learning "O'Reilly Media, Inc."
2. Koller, D. and Friedman, N., 2009. Probabilistic graphical models: principles and techniques. MIT press
3. Goodfellow, I., 2016. Deep Learning-Ian Goodfellow, Yoshua Bengio, Aaron Courville-Google Books

4. Murphy, K.P., 2012. Machine learning: a probabilistic perspective. MIT press
5. Zhou, Z.H., 2012. Ensemble methods: foundations and algorithms. CRC press.

Reference Books:

1. Xiong, J., Hsiang, E.L., He, Z., Zhan, T. and Wu, S.T., 2021. Augmented reality and virtual reality displays: emerging technologies and future perspectives. Light: Science & Applications, 10(1), p.216.
2. Mystakidis, S., 2022. Metaverse. Encyclopedia, 2(1), pp.486-497
3. Gill, S.S., Xu, M., Ottaviani, C., Patros, P., Bahsoon, R., Shaghaghi, A., Golec, M., Stankovski, V., Wu, H., Abraham, A. and Singh, M., 2022. AI for next generation computing: Emerging trends and future directions. Internet of Things, 19, p.100514
4. Mangini, S., Tacchino, F., Gerace, D., Bajoni, D. and Macchiavello, C., 2021. Quantum computing models for artificial neural networks. Europhysics Letters, 134(1), p.10002.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDO8011	AI for financial & Banking Application	L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100(30% Weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		
Course Outcomes	CO1	Gain knowledge of technology's influence on financial and banking enterprises.
	CO2	Understand the applications of blockchain in the financial sector.
	CO3	Recognize digital money transfer mechanisms and its role in digitization
	CO4	Evaluate the advantages of digitization and cloud services in banking.
	CO5	Analyze enterprise software solutions for financial operations.
	CO6	Explore the integration of AI in banking processes.

Module No.	Unit No.	Topics	Ref	Hrs.
1		**Information Technology Infrastructure and Digitization of Financial Banking Enterprises**	1	4
	1.1	Digital Technology driven processes, BlockChain technologies for Financial – Banking sector, GIFT citie Digital Money transfer Mechanisms. Digitization/ cloud services and solutions in banking and financial services Profiling enterprise software's in financial and banking enterprises. Building Efficiencies, productivity, and infallibility in financial & Banking operations. Detailed study of various processes which shall be transformed by AI integration in banking and financial services.		
	1.2	Self-learning: Introduction to business efficiencies, industrial productivity and high degree reliability systems for competitive advantage and carbon neutral enterprises.		
2		**Financial Statistics and The Sharpe Ratio**	1	7
	2.1	Probability, Combinatorics, Mathematical Expectation, Sample Mean, Standard Deviation, and Variance, Sample Skewness and Kurtosis, Sample Covariance and Correlation, Financial Returns, Capital Asset Pricing Model, Sharpe Ratio Formula, Time Periods and Annualizing, Ranking Investment Candidates, The Quantmod Package, Measuring Income Statement Growth, Sharpe Ratios for Income Statement Growth		
3		**Cluster Analysis**	2	7

	3.1	K-Means Clustering, Dissecting the K-Means Algorithm Sparsity and Connectedness of Undirected Graph Covariance and Precision Matrices, Visualizing Covariance, The Wishart distribution Glasso Penalization for Undirected Graphs, Running the Glasso Algorithm, Tracking a Value Stock through the Years Regression on Yearly Sparsity, Regression on Quarterly Sparsity, Regression on Monthly Sparsity		
4		**Gauging the Market Sentiment**	2	7
	4.1	Markov Regime Switching Model, Reading the Market Data, Bayesian Reasoning, The Beta Distribution, Prior and Posterior Distributions, Examining Log Returns for Correlation, Momentum Graphs, Simulating Trading Strategies, Foreign Exchange Markets, Chart Analytics Initialization and Finalization, Momentum Indicators, Bayesian Reasoning within Positions, Entries, Exils, Profitability, Short-Term Volatility, The State Machine		
5		**Trading algorithms**	1,2	7
	5.1	Vectorized Backtesting, Backtesting an SMA-Based Strategy, Backtesting a Daily DNN-Based Strategy Backtesting an Intraday DNN-Based Strategy, Risk Management: Trading Bot, Vectorized Backtesting Event-Based Backtesting, Assessing Risk, Backtesting Risk Measures, Stop Loss, Trailing Stop Loss, Take Profit		
6		**Fraud Analytics**	3	7
	6.1	Introduction, The Analytical Fraud Model Life Cycle, Model Representation, Traffic Light Indicator Approach, Decision Tables, Selecting the Sample to Investigate, Fraud Alert and Case Management, Visual Analytics, Backtesting Analytical Fraud Models: Backtesting Data Stability, Backtesting Model Stability, Backtesting Model Calibration, Model Design and Documentation		
		Total		39

Course Assessment:

ISE-1: Assignment/quiz (20 Marks)
ISE-2: Assignment/quiz (20 Marks)
MSE: 30 Marks written examination based on initial 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

1. Financial Analytics with R Building a Laptop Laboratory for Data Science MARK J. BENNETT University of Chicago DIRK L. HUGEN University of Iowa
2. Artificial Intelligence in Finance A Python-Based Guide, Yves Hilpisch A
3. Fraud Analytics Using Descriptive, Predictive, and Social Network Techniques: A Guide to Data Science for Fraud Detection, Bart Baesens, Veronique Van Vlasselaer, Wouter Verbeke

Reference Books:

1. "Machine Learning for Asset Managers" by Marcos López de Prado
2. "Advances in Financial Machine Learning" by Marcos López de Prado.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
CSDO8012	Quantum Computing		ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100(30% Weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		Engineering Mathematics, Data Structures and Algorithm, Python Programming
Course Outcomes	CO1	Understand basic concepts of quantum computing
	CO2	Illustrate building blocks of quantum computing through architecture and programming models.
	CO3	Appraise various mathematical models required for quantum computing
	CO4	Discuss various quantum hardware building principles.
	CO5	Identify the various quantum algorithms
	CO6	Describe usage of tools for quantum computing.

Module		Topics	Ref	Hrs.
1		**Introduction to Quantum Computing**	1,2,4	7
	1.1	Motivation for studying Quantum Computing, Origin of Quantum Computing, Quantum Computer vs. Classical Computer, Introduction to Quantum mechanics, Overview of major concepts in Quantum Computing		
	1.2	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**	1	5
	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**	1,2	8
	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 perceptive 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**	1,2	6
	4.1	Quantum Algorithms, Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch-Jozsa Algorithm, Quantum error correction using repetition codes		
	4.2	3 qubit codes, Shor's 9 qubit error correction Code		
5		**Quantum Hardware**	2,4	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 the Jaynes-Cummings Hamiltonian, Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms, Superconducting Qubits, Quantum computing with spins: Quantum inverter realized with two exchange coupled spins inquantum dots, A 2-qubit spintronic universal quantum gate.		
6		**OSS Toolkits for implementing Quantum program**	3	3
	6.1	IBM quantum experience, Microsoft Q, RigettiPyQuil (QPU/QVM)		
			Total	39

Course Assessment:

ISE-1: Assignment/Quiz (20 Marks)
ISE-2: Assignment/Quiz (20 Marks)
MSE: 30 Marks written examination based on initial 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

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

Reference Books:

1. Bernard Zygelman, A First Introduction to Quantum Computing and Information, 2018
2. Supriyo Bandopadhyay and Marc Cahy, ―Introduction to Spintronicsl, 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

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDO8013	Reinforcement Learning	L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100(30% Weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		Mathematical concepts of Geometry, Linear Algebra, Calculus, Basic Electronics
Course Outcomes	CO1	Learn how to define RL tasks and the core principles behind the RL, including policies, value functions, deriving Bellman equations.
	CO2	Evaluate work with tabular methods to solve classical control problems.
	CO3	Apply Markov Decision Processes to solve real-world problems.
	CO4	Understand the dynamic programming for policy Evaluation.
	CO5	Implement reinforcement learning problems based on averaging sample returns using Monte Carlo method.
	CO6	Recognize current advanced techniques and applications in RL.

Module No.	Unit No.	Topics	Ref	Hrs.
1		**Introduction to Reinforcement Learning:**	1	6
	1.1	Probability distributions and expected values, and basic linear algebra (e.g., inner products). Reinforcement Learning: Key features and Elements of RL, Types of RL, rewards. Reinforcement Learning Algorithms: Q-Learning, State Action Reward State action (SARSA),		
2		**Bandit problems and online learning:**	1,2	7
	2.1	An n-Armed Bandit Problem, Action-Value Methods Tracking a Nonstationary Problem, Optimistic Initial Values Upper-Confidence-Bound Action Selection Gradient Bandits		
3		**Markov Decision Processes:**	1,2	7
	3.1	The Agent–Environment Interface, The Agent–Environment Interface, Goals and Rewards, Returns, Markov properties, Markov Decision Process, Value Functions and Optimal Value Functions		
4		**Dynamic Programming:**	1,2	7
	4.1	Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration		
5		**Monte Carlo Methods and Temporal-Difference Learning**	1,2	7

	5.1	Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, TD Prediction, TD control using Q-Learning		
6		**Applications and Case Studies**	3,4	5
	6.1	Elevator Dispatching, Dynamic Channel Allocation, Job-Shop Scheduling		
			Total	39

Course Assessment:

ISE-1: Assignment/quiz (20 Marks)
ISE-2: Assignment/quiz (10 Marks)
Activity: Demonstration of case study/mini project (10 Marks)
MSE: 30 Marks written examination based on initial 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

1. Reinforcement Learning: An Introduction, by Richard S. Sutton and Andrew G. Barto
2. Alessandro Palmas, Dr. Alexandra Galina Petre, Emanuele Ghelfi, The Reinforcement Learning Workshop: Learn how to Apply Cutting-edge Reinforcement Learning Algorithms to a Wide Range of Control Problems, 2020 Packt publishing.
3. Phil Winder, Reinforcement Learning Industrial Applications with Intelligent Agents, O'Reilly
4. Dr Engr S M Farrukh Akhtar, Practical Reinforcement Learning, Packt Publishing, 2017.

Reference Books:

1. Maxim Lapan, Deep Reinforcement Learning Hands-On: Apply modern RL methods, with deep Q-networks, value iteration, policy gradients, TRPO, AlphaGo Zero.
2. Alberto Leon-Garcia, Probability, Statistics and Random Processes for Electrical Engineering, Third Edition, Pearson Education, Inc
3. Csaba Szepesv´ari, Algorithms for Reinforcement Learning, Morgan & Claypool Publishers

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDO8021	Graph Data Science	L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100(30% Weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		
Course Outcomes	CO1	Demonstrate a solid understanding of graph concepts and properties.
	CO2	Apply graph algorithms to solve puzzles and optimization problems.
	CO3	Compare graph databases with relational and NoSQL databases.
	CO4	Model data using the labelled property graph model and avoid common pitfalls.
	CO5	Build graph database applications with proper data modeling and testing.
	CO6	Analyze and implement graph database solutions for real-world use cases, considering non-functional characteristics

Module No.	Topics	Ref	Hrs.
1	**Introduction to Graph**	1	4
	Definitions and examples, Three puzzles, Paths and cycles, Connectivity, Eulerian graphs, Hamiltonian graphs, shortest path, Chinese postman problem, travelling salesman problem, trees, properties of trees		
2	**Introduction Graph databases**	2	7
	A High-Level View of the Graph Space, Graph Databases, Graph Compute Engines, The Power of Graph Databases, Performance, Flexibility, Agility, Options for Storing Connected Data, Relational Databases Lack Relationships, NOSQL Databases Also Lack Relationships, Graph databases embraces relationship		
3	**Data Modelling with Graphs**	1,2	7
	Models and Goals, The Labelled Property Graph Mode Querying Graphs, A Comparison of Relational and Graph Modelling, Cross-Domain Models, Common Modelling Pitfalls, Identifying Nodes and Relationships, Avoiding Anti-Patterns		
4	**Building a Graph Database Application**	1,2	7
	Data Modelling, Application Architecture, Testing, Capacity Planning, Importing and Bulk Loading Data		

5	**Graphs in the Real World**	3	7
	Organizations Choose Graph Databases, Common Use Cases, Real-World Examples, Authorization and Access Control, Geospatial and Logistics, Graph Database Internals, Native Graph Processing, Native Graph Storage Programmatic APIs, Kernel API, Core API, Traverse Framework, Non-functional Characteristics		
6	**Case Study**	3	7
	Neo4j – About, Neo4j – Installation, Neo4j – Browser Neo4j - Query Language (Cypher), Neo4j - Create a Node Neo4j - Create a Relationship, Neo4j - Create an Index Neo4j - Create a Constraint, Neo4j - Select Data with MATCH, Neo4j - Import Data from CSV, Neo4j - Drop an Index, Neo4j - Drop a Constraint, Neo4j - Delete a Node, Neo4j - Delete a Relationship		
		Total	39

Course Assessment:

ISE-1: Quiz (10 Marks)
Activity: Assignment (10 Marks)
ISE-2: Quiz (10 Marks)
Activity: Case Study (10 Marks)
MSE: 30 Marks written examination based on initial 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

1. Introduction to Graph Theory Fourth edition, Robin J. Wilson
2. Daphne Koller and Nir Friedman, "Probabilistic Graphical Models: Principles and Techniques", Cambridge, MA: The MIT Press, 2009 (ISBN 978-0-262-0139- 2).
3. Graph databases, Ian Robinson, Jim Webber & Emil Eifrem

Reference Books:

1. "Graph Databases: New Opportunities for Connected Data" by Ian Robinson, Jim Webber, and Emil Eifrém.
2. "Neo4j in Action" by Aleksa Vukotic, Nicki Watt, and Tareq Abedrabbo.
3. "Graph Databases for Beginners" by Mark Needham and Amy E. Hodler.
4. "Practical Neo4j" by Gregory Jordan.
5. "Learning Neo4j" by Rik Van Bruggen.
6. "Graph Database Applications and Concepts with Neo4j" by Dionysios Synodinos.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDO8022	Recommendation Systems	L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100(30% Weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		Artificial Intelligence and Machine Learning, Basic knowledge of Python
Course Outcomes	CO1	To have a broad understanding of the field of Recommendation Systems.
	CO2	In-depth Knowledge of the architecture and models for Collaborative Filtering.
	CO3	Understanding the architecture and working of Content based recommendation systems.
	CO4	Understanding the architecture and basics of Knowledge based recommendation systems.
	CO5	Analyzing hybrid and ensembles recommendation systems.
	CO6	Evaluation of recommendation systems by selecting right evaluation parameter.

Module No.	Unit No.	Topics	Ref	Hrs.
1		**Introduction to Recommendation System**	1,2	6
	1.1	History of recommendation system, Eliciting Ratings, and other Feedback Contributions, Implicit and Implicit Ratings, Recommender system functions.		
	1.2	Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.		
2		**Collaborative Filtering**	1,2	6
	2.1	Architecture of Collaborative Filtering, User-based nearest neighbour recommendation, Item-based nearest neighbour recommendation, Model based and pre-processing based approaches, Clustering for recommendation system, Attacks on collaborative recommender systems, Advantages and drawbacks of Collaborative Filtering.		
3		**Content-based recommendation**	1,2	7
	3.1	Architecture of content-based systems, Content representation and content similarity, Item profiles, Discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity based retrieval, The Role of User Generated Content in the Recommendation Process.		

	3.2	Bayes classifier for recommendation, Regression based recommendation system. Advantages and drawbacks of content-based filtering		
4		**Knowledge based recommendation**	1,2	6
	4.1	Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders, Persistent Personalization in Knowledge-Based Systems, Conversational Recommendation. Search based recommendation, Navigation-based recommendation.		
5		**Ensembled- Based and Hybrid Recommendation System**	1,2	6
	5.1	Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta- level, Limitations of hybridization strategies.		
6		**Evaluating Recommendation System**	1,2	8
	6.1	Characteristics and properties of evaluation research, Evaluation design goals- Accuracy, Coverage, Confidence and Trust, Novelty, Serendipity, Diversity, Robustness, Stability and Scalability.		
	6.2	Comparison between evaluation design of classification model and recommendation system, Error metrics, Decision-Support metrics, User- Centred metrics. Comparative analysis between different types of recommendation systems.		
			Total	39

Course Assessment:

ISE-1: Quiz (10 Marks)
Activity: Assignment (10 Marks)
ISE-2: Quiz (10 Marks)
Activity: Case Study (10 Marks)
MSE: 30 Marks written examination based on initial 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

1. Jannach, D., Zanker, M., Felfernig, A., & Friedrich, G. (2010). Recommender systems: an introduction. Cambridge University Press.
2. Ricci, F., Rokach, L., & Shapira, B. (2011). Introduction to Recommender Systems Handbook. Springer, Boston, MA.

Reference Books:

1. Aggarwal, C. C. (2016). Recommender systems (Vol. 1). Cham: Springer International Publishing.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
CSDO8023	Social Media Analytics		ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100(30% Weightage)	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		Graph Theory, Data Mining, Python/R programming
Course Outcomes	CO1	Understand the concept of social media
	CO2	Understand the concept of social media Analytics and its significance
	CO3	Learners will be able to analyze the effectiveness of social media
	CO4	Learners will be able to use different Social media analytics tools effectively and efficiently.
	CO5	Learners will be able to use different effective Visualization techniques to represent social media analytics.
	CO6	Acquire the fundamental perspectives and hands-on skills needed to work with social media data.

Module No.	Topics	Ref	Hrs.
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	1	6
2	**Social Network Structure, Measures & Visualization** 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.	1,2	6
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 Tools, Social Media Action Analytics - What Is Actions Analytics? Common Social Media Actions, Actions Analytics Tools Social Media Hyperlink Analytics - Types of Hyperlinks, Types of	1	8

	Hyperlink Analytics, Hyperlink Analytics Tools		
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	1,4	6
5	**Social Information Filtering** Social Information Filtering - Social Sharing and filtering, Automated Recommendation systems, Traditional Vs social Recommendation Systems, Understanding Social Media and Business Alignment, Social Media KPI, Formulating a Social Media Strategy, Managing Social Media Risks	1,2	6
6	**Social Media Analytics Applications and Privacy** Social media in public sector - Analyzing public sector social media, analyzing individual users, case study. Business use of Social Media - Measuring success, Interaction and monitoring, case study. Privacy - Privacy policies, data ownership and maintaining privacy online	1,2,3	7
		Total	39

Course Assessment:

ISE-1: Quiz (10 Marks)
Activity: Assignment (10 Marks)
ISE-2: Quiz (10 Marks)
Activity: Case Study (10 Marks)
MSE: 30 Marks written examination based on initial 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Text Books:

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
4. Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011

Reference Books:

1. Social Media Analytics [2015], Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, Avinash Kohirkar, IBM Press
2. Social Media Analytics Strategy_ Using Data to Optimize Business Performance, Alex Gonçalves, A Press 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

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSL801	Advanced AI Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		C/C++/Java/MATLAB
Course Outcomes	CO1	Implement Fuzzy operations and functions towards Fuzzy-rule creations.
	CO2	Build and training Associative Memory Network
	CO3	Build Unsupervised learning based networks
	CO4	Design and implement architecture of Special Networks
	CO5	Implement Neuro-Fuzzy hybrid computing applications
	CO6	Implement Fuzzy operations and functions towards Fuzzy-rule creations.

Suggested list of Experiments:	
Sr. No.	**Name of the Experiment**
1	Design and implement a Hidden Markov Models for outcome prediction
2	Design and implement a Bayesian Network for outcome prediction
3	Design and implement a Gaussian Mixture Models for outcome prediction
4	Build and Train a Generative Multi-Layer Network Model using appropriate dataset
5	Build and Train a Deep Convolution Generative Multi-Layer (DCGAN) Network Model for an image based dataset.
6	Develop a Conditional GAN (CGAN) Network to direct the image generation process of the generator model
7	Train a variational auto encoder using Tensorflow on Fashion MNIST
8	Explore the working of any pre-trained model towards outcome generation
9	Implement and analyze the working of Local Interpretable Model-agnostic Explanations(LIME) supervised model
10	Case-study on the emerging technologies in AI like Metaverse, Augmented reality etc
11	Mini Project Report: For any one chosen real world application as per the syllabus of CSC801: Advanced AI
12	Implementation and Presentation of Mini Project

Course Assessment:

ISE-1: Experiments 1 to 5 (20 Marks)

ISE-2: Experiments 6 to 10 (20 Marks)

Activity: Deep learning with MatLab Course completion and certification (10 Marks)

References:

1. https://nptel.ac.in/courses/106106224
2. https://www.tensorflow.org/tutorials/generative/cvae
3. https://www.analyticsvidhya.com/blog/2022/07/everything-you-need-to-know-about-lime/
4. https://onlinecourses.nptel.ac.in/noc20_cs62/preview
5. https://machinelearningmastery.com/what-are-generative-adversarial-networks-gans/

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDOL8011	AI for financial & Banking application Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Python Programming, Deep Learning, Machine Learning
Course Outcomes	CO1	Proficiency in implementing secure and efficient digital money transfer systems
	CO2	Ability to assess investment performance using risk-adjusted measures
	CO3	Competence in identifying meaningful patterns and segments in financial data
	CO4	Understanding of market sentiment and its impact on trading decisions
	CO5	Practical skills in developing and evaluating trading algorithms.
	CO6	Knowledge of fraud detection methods for financial systems.

Suggested list of Experiments:	
Sr. No.	**Name of the Experiment**
1	Setting up a Digital Money Transfer System
2	Calculating Sharpe Ratios for Investment Portfolios
3	Cluster Analysis of Financial Data for Market Segmentation
4	Analyzing Market Sentiment using the Markov Regime Switching Model
5	Developing and Backtesting a Simple Trading Algorithm
6	Implementing Advanced Risk Management Techniques in Trading Algorithms
7	Fraud Detection using Machine Learning Algorithms
8	Visualizing Fraud Patterns and Analytics
9	Designing and Backtesting Complex Trading Strategies
10	Evaluating and Enhancing the Performance of Trading Algorithms
11	Applying Machine Learning for Predictive Fraud Analytics

Course Assessment:

ISE-1: Practical exam based on 1 to 4 experiments (20 Marks)
ISE-2: Practical exam based on 5 to 8 experiments (20 Marks)
Activity: Mini Project (10 Marks)

References:

1. https://www.eastnets.com/newsroom/digital-transformation-in-the-banking-and-financial-services-sector
2. https://www.techopedia.com/definition/34633/generative-ai

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDOL8012	Quantum Computing Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Python Programming Language.
Course Outcomes	CO1	Implement basic quantum computing logic by building dice and random numbers using open source simulation tools
	CO2	Understand quantum logic gates using open source simulation tools.
	CO3	Implement quantum circuits using open source simulation tools.
	CO4	Implement quantum algorithms using open source simulation tools

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

Course Assessment:

ISE-1: Practical exam based on 1 to 4 experiments (20 Marks)
ISE-2: Practical exam based on 5 to 8 experiments (20 Marks)
Activity: Mini Project (10 Marks)

References:

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

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDOL8013	Reinforcement Learning Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Python Programming, Deep Learning, Machine Learning
Course Outcomes	CO1	Gain a solid understanding of reinforcement learning concepts and problem formulation
	CO2	Evaluate and compare exploration strategies in online learning scenarios.
	CO3	Solve Markov Decision Processes using dynamic programming algorithms
	CO4	Apply dynamic programming techniques to solve small-scale MDP problems.
	CO5	Implement and analyze Monte Carlo methods and Temporal-Difference learning algorithms
	CO6	Explore practical applications of reinforcement learning in real-world domains

Suggested list of Experiments:	
Sr. No.	**Name of the Experiment**
1	Implementing a simple grid-world environment and training an agent using basic Q-learning
2	Implementing a multi-armed bandit problem and comparing different exploration strategies like epsilon-greedy and UCB.
3	Implementing a basic grid-world environment as an MDP and applying policy iteration and value iteration algorithms to find optimal policies
4	Applying dynamic programming algorithms, such as policy evaluation and policy improvement, to solve a small-scale MDP problem.
5	Implementing Monte Carlo control and Temporal Difference (TD) learning algorithms to train an agent in a grid-world environment.
6	Exploration vs. Exploitation Trade-off: Experimenting with different exploration strategies and analyzing their impact on the learning performance of an agent in a bandit problem.
7	Function Approximation in Reinforcement Learning: Using function approximation techniques, such as linear regression or neural networks, to approximate value functions in reinforcement learning problems.
8	Deep Reinforcement Learning: Implementing a deep Q-network (DQN) to train an agent to play a popular Atari game, such as Pong or Space Invaders.

9	Transfer Learning and Multi-Task Reinforcement Learning: Investigating transfer learning in reinforcement learning by training an agent in one environment and transferring its knowledge to a different but related environment
10	Policy Gradient Methods: Implementing policy gradient methods, such as REINFORCE or Proximal Policy Optimization (PPO), to train an agent in a continuous control environment
11	Applications and Case Studies: Applying reinforcement learning techniques to solve a real-world problem, such as training a self-driving car to navigate a simulated road environment

Course Assessment:

ISE-1: Practical exam based on 1 to 4 experiments (20 Marks)
ISE-2: Practical exam based on 5 to 8 experiments (20 Marks)
Activity: Mini Project (10 Marks)

References:

1. Machine Learning and Friends at Carnegie Mellon University
2. Reinforcement Learning: A Survey
3. Bibliography on Reinforcement Learning
4. David J. Finton's Reinforcement Learning Page

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDOL8021	Graph Data Science Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Python Programming, Deep Learning, Machine Learning.
Course Outcomes	CO1	Comprehensive understanding of graph databases and their benefits
	CO2	Proficiency in creating data models for representing complex relationships
	CO3	Ability to write efficient queries and analyze graph data effectively.
	CO4	Competence in administering and managing graph databases
	CO5	Application of graph database techniques to solve real-world problems.
	CO6	Understand developing graph database applications.

Suggested list of Experiments:	
Sr. No.	**Name of the Experiment**
1	Graph Database Fundamentals: • Install and set up a graph database system (e.g., Neo4j) on a local machine. • Familiarize yourself with the graph database environment, including the query language (Cypher) and browser interface
2	Data Modeling with Graphs: • Design a data model using the labeled property graph model for a specific domain (e.g., social network, e-commerce). • Implement the data model in the graph database and populate it with sample data
3	Basic Graph Queries: • Perform basic graph queries using Cypher to retrieve nodes, relationships, and their properties. • Explore different query patterns, such as finding paths, filtering nodes, and ordering results.
4	Advanced Graph Queries: • Extend your query knowledge by performing more complex graph queries, including subgraph matching, aggregation, and conditional filtering. • Optimize query performance by understanding and utilizing indexes.
5	Graph Database Administration: • Learn and practice essential administrative tasks, such as managing users, roles, and access control. • Perform backup and restore operations to ensure data integrity.
6	Importing and Exporting Data: • Import data from external sources (e.g., CSV files) into the graph database. • Export graph data to different formats for analysis or sharing.

7	Graph Algorithms and Analytics: • Explore the built-in graph algorithms provided by the graph database system (e.g., centrality, community detection). • Apply graph algorithms to analyze and extract insights from your graph data
8	Graph Visualization and Exploration: • Utilize visualization tools and libraries to visualize your graph data. • Explore and navigate the graph visually to gain a better understanding of its structure and relationships
9	Performance Optimization: • Identify and address performance bottlenecks in your graph database application. • Optimize queries, indexes, and data modeling to improve overall system performance.
10	Scaling and Replication: • Learn techniques for scaling and replicating a graph database to handle larger datasets and higher workloads. • Implement and test replication strategies to ensure data availability and fault tolerance.
11	Real-World Use Cases: • Choose a specific real-world use case (e.g., recommendation systems, fraud detection) and apply graph database techniques to solve the problem. • Design and implement a graph database application that addresses the unique requirements of the chosen use case.

Course Assessment:

ISE-1: Practical exam based on 1 to 4 experiments (20 Marks)
ISE-2: Practical exam based on 5 to 8 experiments (20 Marks)
Activity: Assignment (10 Marks)

References:

1. https://web4.ensiie.fr/~stefania.dumbrava/OReilly_Graph_Databases.pdf
2. https://www.quackit.com/neo4j/tutorial/

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDOL8022	Recommendation Systems Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Java Python lab
Course Outcomes	CO1	Understand mathematics and representation of data for recommendation systems.
	CO2	Design, implement and analyze Collaborative filtering based for recommendation systems
	CO3	Design, implement and analyze Content-based recommendation systems
	CO4	Design, implement and analyze Knowledge-based recommendation systems.
	CO5	Understanding feature engineering and pre-processing for recommendation systems.
	CO6	To solve real world problems using recommendation systems.

Suggested list of Experiments:	
Sr. No.	Name of the Experiment
1	Implementation of Matrix operations and data representation towards understanding mathematics for recommendation system
2	Experiment on the role of clustering methods with respect to recommendation systems
3	Feature engineering and pre-processing of data for recommendation systems.
4	Implementation of Bayes classifier for recommendation.
5	Implement User-based Nearest neighbor recommendation
6	Implement Item-based Nearest neighbor recommendation
7	Implement Content-based recommendation system.
8	Implement Knowledge-based recommendation system
9	Implementation of a recommendation system using Hybrid approach.
10	Implementation of a recommendation system using Ensembled approach.
11	Implementation of a Regression based recommendation system.
12	Analyze results on the basis of different evaluation parameters and graphical representations for recommendation systems.
13	Mini Project Report: For any one chosen real world Recommendation systems application.
14	Implementation and Presentation of Mini Project

Course Assessment:

ISE-1: Practical exam for 1 to 4 experiments (20 Marks)

ISE-2: Practical exam for 5 to 8 experiments (20 Marks) Activity: Assignment (10 Marks)

References:

1. https://towardsdatascience.com/recommendation-systems-explained-a42fc60591ed
2. https://www.coursera.org/specializations/recommender-systems

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDOL8023	Social Media Analytics Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Types of Graphs, Data Mining, Data Analytics
Course Outcomes	CO1	Understand characteristics and types of social media networks.
	CO2	Use social media analytics tools for business
	CO3	Collect, monitor, store and track social media data
	CO4	Analyze and visualize social media data from multiple platforms
	CO5	Design and develop content and structure based social media analytics models
	CO6	Design and implement social media analytics applications for business

Suggested list of 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 netlytic, etc) 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-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, etc).
4	Exploratory Data Analysis and visualization of Social Media Data for business.
5	Develop Content (text, emoticons, image, audio, video) based social media analytics model for business. (e.g. Content Based Analysis: Topic, Issue, Trend, sentiment/opinion analysis, audio, video, image analytics)
6	Develop Structure based social media analytics model for any business. (e.g. Structure Based Models - community detection, influence analysis)
7	Develop a dashboard and reporting tool based on real time social media data.
8	Design the creative content for promotion of your business on social media platform.
9	Analyze competitor activities using social media data.
10	Develop social media text analytics models for improving existing product/ service by analyzing customer's reviews/comments

Course Assessment:

ISE-1: Practical exam based on 1 to 4 experiments (20 Marks)
ISE-2: Practical exam based on 5 to 8 experiments (20 Marks)
Activity: Assignment (10 Marks)

References:

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, by Raghav Bali, Dipanjan Sarkar, Tushar Sharma. Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013
3. Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013
4. Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO8021	Project Management	L	T	P	L	T	P	Total
		03	--		03	--		03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Apply selection criteria and select an appropriate project from different options.
	CO2	Write work break down structure for a project and develop a schedule based on it.
	CO3	Identify opportunities and threats to the project and decide an approach to deal with them strategically.
	CO4	Use Earned value technique and determine & predict status of the project.
	CO5	Capture lessons learned during project phases and document them for future reference

Module No.	Unit No.	Topics	Ref.	Hrs
1.	1.1	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	1,2,4 ,5	5
2.	2.1	**Initiating Projects:** How to get a project started, Selecting project 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	1	6
3.	3.1	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	1	8
4.	4.1	**Planning Projects** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk	1	6

		identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks		
5.	5.1	**Executing Projects**: Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings.	1,3	8
	5.2	Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit		
	5.3	Project procurement management, contracting and outsourcing		
6.	6.1	**Project Leadership and Ethics** : Introduction to project leadership, ethics in projects. Multicultural and virtual projects	1,3	6
	6.2	Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.		
			Total	**39**

Course Assessment:

ISE-1: Assignments for 10 Marks

Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO8022	Finance Management	L	T	P	L	T	P	Total
		03	--		03	--		03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Understand Indian finance system and corporate finance
	CO2	Take investment, finance as well as dividend decisions

Module No.	Unit No.	Topics	Ref.	Hrs
1.	1.1	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System.	1,2,4	6
	1.2	**Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills		
	1.3	**Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market		
	1.4	**Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges		
2.	2.1	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.	1,3	6
	2.2	**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.	3.1	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.	1	9

	3.2	**Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis		
4.	4.1	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; 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)	1	10
	4.2	**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.	5.1	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.	1	5
		Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and 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.	6.1	Dividend Policy: 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	4	3
			Total	**39**

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended 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.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO8023	Entrepreneurship Development and Management	L	T	P	L	T	P	Total
		03	--		03	--		03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Understand the concept of business plan and ownerships
	CO2	Interpret key regulations and legal aspects of entrepreneurship in India
	CO3	Understand government policies for entrepreneurs

Module No.	Topics	Ref.	Hrs.
1.	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	1	4
2.	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	2	9
3.	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	3	5
4.	Indian Environment for Entrepreneurship: 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 organizations, departments, banks etc., 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	3	8
5.	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-	4	8

	Marketing		
6.	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	3	5
		Total	39

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]
ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks
MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

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

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO8024	Human Resource Management	L	T	P	L	T	P	Total
		03	--		03	--		03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Understand the concepts, aspects, techniques and practices of the human resource management.
	CO2	Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
	CO3	Gain knowledge about the latest developments and trends in HRM.
	CO4	Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers

Module No.	Unit No.	Topics	Ref.	Hrs
1.		**Introduction to HR**	1,2	5
	1.1	Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager,HRM functions.		
	1.2	Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.		
2.		**Organizational Behavior (OB)**	1,2	7
	2.1	Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues		
	2.2	Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness Perception: Attitude and Value, Effect of perception on Individual Decision making, Attitude and Behavior.		
	2.3	Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);		
	2.4	Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study		
3.		**Organizational Structure & Design**	2	6

	3.1	Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies		
4.		**Human resource Planning**	1	5
	4.1	Recruitment and Selection process, Job enrichment, Empowerment- Job- Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. Training & Development: Identification of Training Needs, Training Methods		
5.		**Emerging Trends in HR**	1,3	6
	5.1	Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment.		
	5.2	Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation		
6.		**HR & MIS Strategic HRM**	1,2	10
	6.1	Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries.		
	6.2	Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals		
	6.3	Labor Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act		
			Total	**39**

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)	L	T	P	L	T	P	Total
		03	--		03	--		03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Understand rights and duties of business
	CO2	Distinguish different aspects of corporate social responsibility
	CO3	Demonstrate professional ethics
	CO4	Understand legal aspects of corporate social responsibility

Module No.	Unit No.	Topics	Ref.	Hrs
1.	1.1	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	1,2	4
2.	2.1	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy	3	8
	2.2	**Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources		
3.	3.1	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs	3	6
4.	4.1	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	1	5
5.	5.1	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in Indi	1	8
6.	6.1	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013	1	8

Total	**39**

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO8026	Research Methodology	L	T	P	L	T	P	Total
		03	--		03	--		03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100(30% Weightage)	100	

Pre-requisite Course Codes		
Course Outcomes	CO1	Prepare a preliminary research design for projects in their subject matter areas
	CO2	Accurately collect, analyze and report data
	CO3	Present complex data or situations clearly
	CO4	Review and analyze research findings

Module No.	Unit No.	Topics	Ref.	Hrs.
1.		**Introduction and Basic Research Concepts**	1,2	9
	1.1	Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology		
	1.2	Need of Research in Business and Social Sciences		
	1.3	Objectives of Research		
	1.4	**Issues** and Problems in Research		
	1.5	Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical		
2.		**Types of Research**	1	7
	2.1	Basic Research		
	2.2	Applied Research		
	2.3	Descriptive Research		
	2.4	Analytical Research		
	2.5	Empirical Research		
	2.6	Qualitative and Quantitative Approaches		
3.		**Research Design and Sample Design**	1	7
	3.1	Research Design – Meaning, Types and Significance		
	3.2	Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors		
4.		**Research Methodology**	2	8
	4.1	Meaning of Research Methodology		

	4.2	Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f.** Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report		
5.		**Formulating Research Problem**	3	4
	5.1	Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis		
6.		**Outcome of Research**	3	4
	6.1	Preparation of the report on conclusion reached		
	6.2	Validity Testing & Ethical Issues		
	6.3	Suggestions and Recommendation		
			Total	**39**

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]
ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks
MSE: 30 Marks written examination based on initial 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO8027	IPR and Patenting	L	T	P	L	T	P	Total
		3	--		3	--		3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	understand Intellectual Property assets
	CO2	assist individuals and organizations in capacity building
	CO3	work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module No.	Unit No.	Topics	Ref.	Hrs.
1.	1.1	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, TradeMarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc.	1	5
	1.2	**Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development		
2.	2.1	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement	2	7
	2.2	**Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.		
3.	3.1	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	4	5
4.	4.1	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method	1,2	7

5.	5.1	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	1,4	8
6.	6.1	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	5,6	7
			Total	**39**

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO8028	Digital Business Management	L	T	P	L	T	P	Total
		03	--		03	--		03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Identify drivers of digital business
	CO2	Illustrate various approaches and techniques for E-business and management
	CO3	Prepare E-business plan

Module No.	Unit No.	Topics	Ref.	Hrs.
1. -	1.1	**Introduction to Digital Business**: Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, Opportunities and Challenges in Digital Business,	1,2,3	9
	1.2	**Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services)		
2.	2.1	**Overview of E-Commerce :-** Meaning, Retailing in e-commerce-products and services, consumer behaviour, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals	1,2	6
	2.2	Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC		
3.	3.1	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system	3	6
	3.2	Application Development: Building Digital business Applications and Infrastructure		

4.	4.1	**Managing E-Business :**Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	1,2,4	6
5.	5.1	**E-Business Strategy** E-business Strategic formulation-Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	3,4	4
6.	6.1	**Materializing e-business :**From Idea to Realization-Business plan preparation Case Studies and presentations	5	8
			Total	**39**

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus

ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

1. A textbook on E-commerce, ErArunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective - DOI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ILO8029	Environmental Management	L	T	P	L	T	P	Total
		03	--		03	--		03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100(30% Weightage)		100

Pre-requisite Course Codes		
Course Outcomes	CO1	Understand the concept of environmental management
	CO2	Understand ecosystem and interdependence, food chain etc.
	CO3	Understand and interpret environment related legislations

Module No.	Topics	Ref.	Hrs.
1.	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	1,2	10
2.	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man- made disasters, Atomic/Biomedical hazards, etc.	1,2	6
3.	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	1,2	5
4.	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	5,6	10
5.	Total Quality Environmental Management, ISO-14000, EMS certification	5,6	5
6.	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.	5,6,7	3
		Total	39

Course Assessment:

ISE-1: Assignments for 10 Marks
Multiple choice questions (MCQ) quiz for 10 Marks [1 hour duration]

ISE-2: Seminars based on Case study/Application in practical, real-life domain for 20 Marks

MSE: 30 Marks written examination based on initial 50% syllabus
ESE: Three hours 100 marks(30% weightage) written examination based on entire syllabus

Recommended Books:

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

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSP801	Major Project 2	L	T	P	L	T	P	Total
		--	--	12	--	--	6	6
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	50	--	50	50	150	

Pre-requisite Course Codes		
Course Outcomes	CO1	Identify problems based on societal/research needs.
	CO2	Apply Knowledge and skill to solve societal problems in a group
	CO3	Draw the proper inferences from available results through theoretical/ experimental/simulations
	CO4	Analyse the impact of solutions in societal and environmental context for sustainable development. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning
	CO5	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning
	CO6	Demonstrate project management principles during project work.

Guidelines:

1. Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work Marks.
2. **Project Report Format:**
   At the end of semester, each group needs to prepare a project report as per the guidelines issued by the University of Mumbai. Report should be submitted in hardcopy. Also, each group should submit softcopy of the report along with project documentation, implementation code, required utilities, software and user Manuals.
   A project report should preferably contain at least following details:
   - Abstract
   - Introduction
   - Literature Survey/ Existing system
   - Limitation Existing system or research gap
   - Problem Statement and Objective
   - Proposed System
   - Analysis/Framework/ Algorithm
   - Design details
   - Methodology (your approach to solve the problem) Proposed System
   - Experimental Set up
   - Details of Database or details about input to systems or selected data
   - Performance Evaluation Parameters (for Validation)
   - Software and Hardware Setup
   - Results and Discussion
   - Conclusion and Future Work
   - References

- Appendix – List of Publications or certificates

Desirable:
Students should be encouraged –

- To participate in various project competition.
- To write minimum one technical paper & publish in good journal.
- To participate in national / international conference.

Course Assessment:

ISE-1: Implementation & Presentation (50 Marks)
ISE-2: Report Writing, Poster Presentation and paper publication (50 Marks)
ESE: Project Exam (50 Marks)

Suggested quality evaluation parameters are as following:

a. Relevance to the specialization / industrial trends
b. Modern tools used
c. Innovation
d. Quality of work and completeness of the project
e. Validation of results
f. Impact and business value
g. Quality of written and oral presentation
h. Individual as well as teamwork