University of Mumbai

Bachelor of Engineering

in

- Computer Science and Engineering (Data Science)
- Computer Science and Engineering (Artificial Intelligence and Machine Learning)
- Artificial Intelligence and Data Science
- Artificial Intelligence and Machine Learning
- Data Engineering

Fourth Year with Effect from AY 2023-24

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

University of Mumbai

Sr. No.	Heading	Particulars
1	Title of the Course	**Fourth Year Engineering**
2	Eligibility for Admission	**After Passing Second Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances/ Regulations(if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New**/ ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year:2023-2024**

Dr. S.K.Ukarande
Associate Dean,
Faculty of Science and Technology
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Dr. Anuradha Muzumdar
Dean,
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal meansof quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2021-22. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2022-23, 2023-24, respectively.

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Incorporation and Implementation of Online Contents fromNPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preface by Board of Studies in
Computer Engineering

Dear Students and Teachers, we, the members of Board of Studies Computer Engineering, are very happy to present Fourth Year Computer Engineering Specialization in Data Science, Data Engineering, Artificial Intelligence and Machine leaning syllabus effective from the Academic Year 2021-22 (REV-2019'C' Scheme). We are sure you will find this syllabus interesting, challenging, fulfill certain needs and expectations.

Emerging Programs in the field of Computer Engineering is one of the most sought-after courses amongst engineering students. The syllabus needs revision in terms of preparing the student for the professional scenario relevant and suitable to cater the needs of industry in present day context. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. It is intended to provide a modern, industry-oriented education in Computer Engineering. It aims at producing trained professionals who can successfully acquaint with the demands of the industry worldwide. They obtain skills and experience in up-to-date the knowledge to analysis, design, implementation, validation, and documentation of computer software and systems.

The revised syllabus is finalized through a brain storming session attended by Heads of Departments or senior faculty from the Department of Computer Engineering of the affiliated Institutes of the Mumbai University. The syllabus falls in line with the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

The salient features of the revised syllabus are:
1. Reduction in credits to 170 is implemented to ensure that students have more time for extracurricular activities, innovations, and research.
2. The department Optional Courses will provide the relevant specialization within the branch to a student.
3. Introduction of Skill Based Lab and Mini Project to showcase their talent by doing innovative projects that strengthen their profile and increases the chance of employability.
4. Students are encouraged to take up part of course through MOOCs platform SWAYAM

We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Board of Studies in Computer Engineering

Prof. Sunil Bhirud	: Chairman
Prof. SunitaPatil	: Member
Prof. Leena Ragha	: Member
Prof. Subhash Shinde	: Member
Prof .Meera Narvekar	: Member
Prof. Suprtim Biswas	: Member
Prof. Sudhir Sawarkar	: Member
Prof. Dayanand Ingle	: Member
Prof. Satish Ket	: Member

Program Structure for Fourth Year CSE (AIML), CSE (DS) AI&DS, DE, AI&ML

UNIVERSITY OF MUMBAI (With Effect from 2023-2024)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
CSC701	Deep Learning	3	--	3	--	3
CSC702	Big Data Analytics	3	--	3		3
CSDO 701X	Department Level Optional Course-3	3	--	3	--	3
CSDO 702X	Department Level Optional Course-4	3	--	3	--	3
ILO 701X	Institute Level Optional Course-1	3	--	3	--	3
CSL701	Deep Learning Lab	--	2	--	1	1
CSL702	Big Data Analytics Lab	--	2	--	1	1
CSDOL 701X	Department Level Optional Course-3 Lab	--	2	--	1	1
CSDOL 702X	Department Level OptionalCourse-4 Lab	--	2	--	1	1
CSP701	Major Project1	--	6$^{\#}$	--	3	3
Total		**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
CSC701	Deep Leaning	20	20	20	80	3	--	--	100
CSC702	Big Data Analytics	20	20	20	80	3	--	--	100
CSDO 701X	Department Level Optional Course-3	20	20	20	80	3	--	--	100
CSDO 702X	Department Level Optional Course-4	20	20	20	80	3	--	--	100
ILO 701X	Institute Level Optional Course-1	20	20	20	80	3	--	--	100
CSL701	Deep Leaning Lab	--	--	--	--	--	25	25	50
CSL702	Big Data Analytics Lab	--	--	--	--	--	25	25	50
CSDOL 701X	Department Level Optional Course-3 Lab						25	-	25
CSDOL 702X	Department Level OptionalCourse-4 Lab	--	--	--	--	--	25	-	25
CSP701	Major Project1	--	--	--	--	--	50	25	75
Total		**--**	**--**	**100**	**400**	**--**	**150**	**75**	**725**

Program Structure for Fourth Year CSE (AIML), CSE (DS) AI&DS, DE, AI&ML

UNIVERSITY OF MUMBAI (With Effect from 2023-2024)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
CSC801	Advanced Artificial Intelligence	3	--	3	--	3
CSDO 801X	Department Level Optional Course-5	3	--	3	--	3
CSDO 802X	Department Level Optional Course-6	3	--	3	--	3
ILO 801X	Institute Level Optional Course-2	3	--	3	--	3
CSL801	Advanced Artificial Intelligence Lab	--	2	--	1	1
CSDOL 801X	Department Level OptionalCourse-5 Lab	--	2	--	1	1
CSDOL 802X	Department Level OptionalCourse-6 Lab	--	2	--	1	1
CSP801	Major Project-2	--	12#	--	6	6
Total		**12**	**18**	**12**	**9**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
CSC801	Advanced Artificial Intelligence	20	20	20	80	3	--	--	100
CSDO801X	Department Level Optional Course-5	20	20	20	80	3	--	--	100
CSDO 802X	Department Level Optional Course-6	20	20	20	80	3	--	--	100
ILO80X	Institute Level Optional Course-2	20	20	20	80	3	--	--	100
CSL801	Advanced Artificial Intelligence Lab	--	--	--	--	--	25	25	50
CSDOL 801X	Department Level Optional Course -5 Lab	--	--	--	--	--	25	25	50
CSDOL 802X	Department Level Optional Course -6 Lab						25	25	50
CSP801	Major Project 2	--	--	--	--	--	100	50	150
Total		**--**	**--**	**80**	**320**	**--**	**175**	**125**	**700**

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

Program Structure for Fourth Year CSE (AIML), CSE (DS) AI&DS, DE, AI&ML
UNIVERSITY OF MUMBAI (With Effect from 2023-2024)
Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject and Labs
VII	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-I	ILO7011:Product Lifecycle Management ILO7012: Reliability Engineering ILO7013.: Management Information System ILO7014: Design of Experiments ILO7015: Operation Research ILO7016: Cyber Security and Laws ILO7017: Disaster Management & Mitigation Measures ILO7018: Energy Audit and Management ILO7019: Development Engineering

Program Structure for Fourth Year CSE (AIML), CSE (DS) AI&DS, DE, AI&ML
UNIVERSITY OF MUMBAI (With Effect from 2023-2024)
Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject and Labs
VIII	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-II	ILO8021: Project Management ILO8022: Finance Management ILO8023: Entrepreneurship Development and Management ILO8024: Human Resource Management ILO8025: Professional Ethics and CSR ILO8026: Research Methodology ILO8027: IPR and Patenting ILO8028: Digital Business Management ILO8029: Environmental Management

Course Code:	Course Title	Credit
CSC701	Deep Learning	3

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

Module		Content	39Hrs
1		**Fundamentals of Neural Network**	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**	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**	6
	3.1	Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders	

	3.2	Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders	
	3.3	Application of Autoencoders: Image Compression	
4		**Convolutional Neural Networks (CNN): Supervised Learning**	**7**
	4.1	Convolution operation, Padding, Stride, Relation between input, outpu 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)**	**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**	**4**
	6.1	Generative Adversarial Network (GAN): Architecture	
	6.2	Applications: Image Generation, DeepFake	

Textbooks:	
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville. ―Deep Learning‖, MIT Press Ltd, 2016
2	Li Deng and Dong Yu, ―Deep Learning Methods and Applications‖, Publishers Inc.
3	Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4	JM Zurada ―Introduction to Artificial Neural Systems‖, Jaico Publishing House
5	M. J. Kochenderfer, Tim A. Wheeler. ―Algorithms for Optimization‖, MIT Press.
References:	
1	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

Assessment:	
Internal Assessment:	
The assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All questions carry equal marks.
3	Question 1 and question 6 will have questions from all modules. Remaining 4 questions will be based on the remaining 4 modules.

4	Only four questions need to be solved.
5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	http://www.cse.iitm.ac.in/~miteshk/CS6910.html
2	https://nptel.ac.in/courses/106/106/106106184/
3	https://www.deeplearningbook.org/

Course Code	Course/Subject Name	Credits
CSC702	Big Data Analytics	3

Prerequisite: Some prior knowledge about Java programming, Basics of SQL, Data mining and machine learning methods would be beneficial.

Course Objectives:	
1	To provide an overview of an exciting growing field of big data analytics.
2	To introduce programming skills to build simple solutions using big data technologies such as MapReduce and scripting for NoSQL, and the ability to write parallel algorithms for multiprocessor execution
3	To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4	To enable students to have skills that will help them to solve complex real-world problems in decision support.
5	To provide an indication of the current research approaches that is likely to provide a basis for tomorrow's solutions.

Course Outcomes:	
1	Understand the key issues in big data management and its associated applications for business decisions and strategy.
2	Develop problem solving and critical thinking skills in fundamental enabling techniques like Hadoop, Map reduce and NoSQL in big data analytics.
3	Collect, manage, store, query and analyze various forms of Big Data.
4	Interpret business models and scientific computing paradigms,and apply software tools for big data analytics.
5	Adapt adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.
6	Solve Complex real world problems in various applications like recommender systems, social media applications, health and medical systems, etc.

Module		Detailed Contents	Hours
1		**Introduction to Big Data & Hadoop**	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 ofBig Data Solutions.	
	1.5	Concept of Hadoop	
	1.6	Core Hadoop Components; Hadoop Ecosystem	
2		**Hadoop HDFS and Map Reduce**	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 Failures.	
	2.3	Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce .	
	2.4	Hadoop Limitations .	
3		**NoSQL**	5
	3.1	Introduction to NoSQL, NoSQL Business Drivers.	
	3.2	NoSQL DataArchitecture 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 ashared-nothing architecture; Choosing distribution models: master-slaveversus 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 Stream**	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 Itemsin a Stream, Sampling Methods for Streams, Frequent Itemsets in Decaying Windows.	
	4.6	Counting Ones in a Window: The Cost of ExactCounts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows.	

5		**Finding Similar Items and Clustering**	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**	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.	

Textbooks:	
1	Anand Rajaraman and Jeff Ullman ―Mining of Massive Datasets‖, Cambridge UniversityPress,
2	Alex Holmes ―Hadoop in Practice‖, Manning Press, Dreamtech Press.
3	Dan Mcary and Ann Kelly ―Making Sense of NoSQL‖ – A guide for managers and the restof us, Manning Press.

References:	
1	Bill Franks , ―Taming The Big Data Tidal Wave: Finding Opportunities In Huge DataStreams 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 BusinessLeaders 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

Assessment:	
Internal Assessment:	
The assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All questions carry equal marks.
3	Question 1 and question 6 will have questions from all modules. Remaining 4 questions will be based on the remaining 4 modules.
4	Only four questions need to be solved.
5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code:	Course Title	Credit
CSDO7011	**Natural Language Processing**	**3**

Prerequisite: Artificial Intelligence and Machine Learning, Basic knowledge of Python	
Course Objectives:	
1	To understand natural language processing and to learn how to apply basic algorithms in this field
2	To get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics
3	To design and implement various language models and POS tagging techniques
4	To design and learn NLP applications such as Information Extraction, Question answering
5	To design and implement applications based on natural language processing
Course Outcomes:	
1	To have a broad understanding of the field of natural language processing
2	To design language model for word level analysis for text processing
3	To design various POS tagging techniques
4	To design, implement and test algorithms for semantic analysis
5	To develop basic understanding of Pragmatics and to formulate the discourse segmentation and anaphora resolution
6	To apply NLP techniques to design real world NLP applications

Module		Content	Hrs
1		**Introduction**	**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**	**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**	**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**	**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**	**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)**	**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.	

Textbooks:	
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 Processing, MIT Press, 1999.

References:	
1	Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2	Daniel M Bikel and ImedZitouni ― Multilingual natural language processing applications: from theory to practice, IBM Press, 2013.
3	Nitin Indurkhya and Fred J. Damerau, ―Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.

Useful Links	
1	https://onlinecourses.nptel.ac.in/noc21_cs102/preview
2	https://onlinecourses.nptel.ac.in/noc20_cs87/preview
3	https://nptel.ac.in/courses/106105158

Assessment:
Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus

Course Code	Course/Subject Name	Credits
CSDO7012	AI for Healthcare	3

Course Prerequisites:	
Artificial Intelligence, Machine Learning	
Course Objectives: The course aims	
1	To understand the need and significance of AI and ML for Healthcare.
2	To study advanced AI algorithms for Healthcare.
3	To learn Computational Intelligence techniques .
4	To understand evaluation metrics and ethics in intelligence for Healthcare systems,
5	To learn various NLP algorithms and their application in Healthcare,
6	To investigate the current scope, implications of AI and ML for developing futuristic Healthcare Applications.
Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Understand the role of AI and ML for handling Healthcare data.
2	Apply Advanced AI algorithms for Healthcare Problems.
3	Learn and Apply various Computational Intelligence techniques for Healthcare Application.
4	Use evaluation metrics for evaluating healthcare systems.
5	Develop NLP applications for healthcare using various NLP Techniques..
6	Apply AI and ML algorithms for building Healthcare Applications

Module		Topics	Hours
1		**Introduction**	06
	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**	08
	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**	04
	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**	08
	4.1	NLP tasks in Medicine, Low-level NLP components, High level NLP components, NLPMethods.	

	4.2	Clinical NLP resources and Tools, NLP Applications in Healthcare. Model Interpretability using Explainable AI for NLP applications.	
5		**Intelligent personal Health Record**	**05**
	5.1	Introduction, Guided Search for Disease Information, Recommending SCA's. Recommending HHP's , Continuous User Monitoring.	
6		**Future of Healthcare using AI**	**08**
	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.	

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 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

Assessment:
Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code:	Course Title	Credit
CSDO7013	**Neural Networks and Fuzzy Systems**	3

Prerequisite: Engineering Mathematics, Data Structures and Algorithm, Python Programming

Course Objectives:

1	To relate to the basic terminologies with respect to Fuzzy set theory.
2	To analyze and interpret fuzzy logic principles, relations and operations.
3	To recognize various components of Associative Memory Networks.
4	To have basic understanding of Unsupervised learning through Networks.
5	To understand Special networks and its applications in soft computing.
6	To infer the significance of Hybrid computing.

Course Outcomes: After successful completion of the course student will be able to

1	Acquire basic knowledge of fuzzy set theory properties and relations.
2	Implement Fuzzy operations towards Fuzzy-rule creations.
3	Gain familiarity with the training and implementation of Associative Memory Network.
4	Understand the architecture and basics components of Unsupervised learning networks.
5	Analyze the significance and working of the Special Networks.
6	Interpret Hybrid System to analyze the Principles of Soft computing in Neuro-Fuzzy applications.

Module		Content	Hrs
1.0		**Fuzzy Set Theory**	**07**
	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.	
2.0		**Fuzzy Rules, Reasoning, and Inference System**	**08**

	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.	
3.0		**Associative Memory Networks**	**06**
	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.	
4.0		**Unsupervised Learning Networks**	**08**
	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.	
5.0		**Special Network**	**05**
	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	

6.0		Hybrid Computing	05
	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.	

Textbooks:	
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

References:	
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

Digital References:
https://onlinecourses.nptel.ac.in/noc22_ee21/preview
https://onlinecourses.nptel.ac.in/noc23_ge15/preview

Assessment:
Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.
End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code:	Course Title	Credit
CSDO7021	**User Experience Design with VR**	**3**

Prerequisite: Web Technologies; Software Engineering
Course Objectives:
1   To study and understand importance of user experience design principles
2   To understand elements of user experience design
3   To encourage students to participate in designing futuristic applications
4   To understand the need and significance of Virtual Reality
5   To understand the technical and engineering aspects of virtual reality systems
Course Outcomes:
1   To Apply principles of user experience
2   To apply emerging and established technologies to enhance User Experience design
3   To create interface for international standards with ethics
4   To evaluate user experience.
5   Describe how VR systems work and list the applications of VR
6   Design and implementation of the hardware that enables VR systems to be built

Module		Content	Hrs
1		**Introduction**	**04**
	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:**	**08**
	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	06
	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	05
	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	08
	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	08
	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	

Textbooks:	
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
References:	

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

Assessment:
Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus

Useful Links	
1	https://archive.nptel.ac.in/courses/124/107/124107008/
2	https://nptel.ac.in/courses/106106138
3	https://www.coursera.org/specializations/virtual-reality

Course Code:	Course Title	Credit
CSDO7022	**Blockchain Technologies**	**3**

Prerequisite: Cryptography and Distributes systems	
Course Objectives:	
1	To get acquainted with the concept of Distributed ledger system and Blockchain.
2	To learn the concepts of consensus and mining in Blockchain through the Bitcoin network.
3	To understand Ethereum and develop-deploy smart contracts using different tools and frameworks.
4	To understand permissioned Blockchain and explore Hyperledger Fabric.
5	To understand different types of crypto assets.
Course Outcomes:	
1	Describe the basic concept of Blockchain and Distributed Ledger Technology.
2	Interpret the knowledge of the Bitcoin network, nodes, keys, wallets and transactions
3	Implement smart contracts in Ethereum using different development frameworks.
4	Develop applications in permissioned Hyperledger Fabric network.
5	Interpret different Crypto assets and Crypto currencies
6	Analyze the use of Blockchain with AI, IoT and Cyber Security using case studies.

Module		Content	Hrs
1		**Introduction to Blockchain**	**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**	**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, transaction in the bitcoin network.	
3		**Ethereum and Smart Contracts**	**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**	**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**	**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**		**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.		

Textbooks:	
1.	Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A and Meena Karthikeyen, 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.
References:	
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 the Technology that Powers Them, Antony Lewis. for Ethereum and Blockchain, Ritesh Modi, Packt publication. University of Mumbai, B. E. (Information Technology), Rev 2016 276

Assessment:
Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus

Useful Links	
1	NPTEL courses: Blockchain and its Applications, Blockchain Architecture Design and Use Cases
2	https://ethereum.org/en/
3	https://www.trufflesuite.com/tutorials
4	https://hyperledger-fabric.readthedocs.io/en/release-2.2/
5	**Blockchain demo:** https://andersbrownworth.com/blockchain/
6	**Blockchain Demo:** Public / Private Keys & Signing: https://andersbrownworth.com/blockchain/public-private-keys/

Course Code:	Course Title	Credit
CSDO7023	**Game Theory for Data Science**	3

Prerequisite: Probability Algebra

Sr. No.	Course Objectives
1.	To introduce the student to the notion of a game, its solutions concepts, and other basic notions and tools of game theory, and the main applications for which they areappropriate, including electronic trading markets.
2.	To formalize the notion of strategic thinking and rational choice by using the toolsof game theory, and to provide insights into using game theory in modeling applications.
3.	To draw the connections between game theory, computer science, and economics,especially emphasizing the computational issues.
4.	To introduce contemporary topics in the intersection of game theory, computerscience, and economics.
5.	To apply game theory in searching, auctioning and trading.

Sr.No.	Course Outcomes
On successful completion, of course, learner/student will be able to:	
1.	Analyze and Discuss the notion of a strategic game and equilibria and identify the characteristics of main applications of these concepts.
2.	Discuss the use of Nash Equilibrium for other problems. Identify key strategic aspectsand based on these be able to connect them to appropriate game theoretic concepts given a real world situation.
3.	Identify some applications that need aspects of Bayesian Games. Implement a typicalVirtual Business scenario using Game theory.
4.	Identify and discuss working principle of Non-Cooperative Games
5.	Discuss the Mechanism for Design Aggregating Preferences
6.	Identify and discuss working principle : Repeated Games

Module		Detailed Content	Hours
0		**Prerequisite :** Probability , Algebra	1
1		**Introduction**	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 PerfectInformation**	7
	2.1	Strategic games – prisoner's dilemma, matching pennies -Nash equilibria – theory and illustrations – Cournot's 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**	6
	3.1	Games with Imperfect Information – Bayesian Games – Motivational Examples – General Definitions – Informationaspects – Illustrations – Extensive Games with Imperfect – Information – Strategies – Nash Equilibrium – Beliefs and sequential equilibrium – Illustrations – Repeated Games – The Prisoner's Dilemma – Bargaining.	
4		**Non-CooperativeGame Theory**	7
	4.1	Non-cooperative Game Theory – Self-interested agents – Games in normal form – Analyzing games: from optimalityto equilibrium – Computing Solution Concepts of Normal –Form Games – Computing Nash equilibria of two-player, zero-sum games –Computing Nash equilibria of two-player,generalsum games – Identifying dominated strategies	
5		**Mechanism DesignAggregating Preferences:**	6
	5.1	Social Choice – Formal Model – Voting – Existence of social functions – Ranking systems – Protocols for StrategicAgents: 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**	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	

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.

Digital References:
1. https://nptel.ac.in/courses/110104063
2. https://onlinecourses.nptel.ac.in/noc19_ge32/preview

Assessment:
Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code	Course Name	Credits
ILO7011	**Product Life Cycle Management**	**03**

Course Objectives:	
1	To familiarize the students with the need, benefits and components of PLM
2	To acquaint students with Product Data Management & PLM strategies
3	To give insights into new product development program and guidelines for designing and developing a product
4	To familiarize the students with Virtual Product Development

Course Outcomes:	
1	Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2	Illustrate various approaches and techniques for designing and developing products.
3	Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4	Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module		Contents	Hrs
1	1.1	**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.	10
	1.2	**PLM Strategies** Industrial strategies, Strategy elements, its identification, selection andimplementation, Developing PLM Vision and PLM Strategy, Change management for PLM	
2	2.1	**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 Propertiesand Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09

3	3.1	**Product Data Management (PDM):** Product and Product Data, PDM systems andimportance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation		05
4	4.1	**Virtual Product Development Tools** For components, machines, 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		05
5	5.1	**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		05
6	6.1	**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		05

Text Book & References:	
1	John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2	Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3	SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4	Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Assessment:
Internal Assessment:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either aclass test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papersof end semester examination. **In question paper weightage of each module will be proportional to number ofrespective lecture hours as mention in the syllabus.**

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus

Course Code	Course Name	Credits
ILO7012	**Reliability Engineering**	**03**

Course Objectives:	
1	To familiarize the students with various aspects of probability theory
2	To acquaint the students with reliability and its concepts
3	To introduce the students to methods of estimating the system reliability of simple and complex systems
4	To understand the various aspects of Maintainability, Availability and FMEA procedure

Course Outcomes:	
1	Understand and apply the concept of Probability to engineering problems
2	Apply various reliability concepts to calculate different reliability parameters
3	Estimate the system reliability of simple and complex systems
4	Carry out a Failure Mode Effect and Criticality Analysis

Module		Contents	Hours
01	1.1	**Probability theory** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.	08
	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.	
02	2.1	**Reliability Concepts** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.	08
	2.2	**Failure Data Analysis** Hazard rate, 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.	
03	3.1	**System Reliability** System Configurations: Series, parallel, mixedconfiguration, k out of n structure, Complex systems.	05
04	4.1	**Reliability Improvement** Redundancy Techniques: Element redundancy, Unitredundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path	08

		method, Decomposition method.	
05	5.1	**Maintainability and Availability** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	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, Fau1t tree analysis and Event tree Analysis	05

Text Book & References:
1	L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2	Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3	B.S. Dhillion, 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 McGraw-Hill Publishing Co. Ltd.

Assessment:

Internal Assessment:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either aclass test or assignment on live problems or course project.

End Semester Theory Examination:

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Course Code	Course Name	Credits
ILO7013	**Management Information System**	**03**

Course Objectives:	
1	The course is blend of Management and Technical field.
2	Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3	Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4	Identify the basic steps in systems development

Course Outcomes:	
1	Explain how information systems Transform Business
2	Identify the impact information systems have on an organization
3	Describe IT infrastructure and its components and its current trends
4	Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5	Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module		Detailed Contents	Hrs
01	1.1	**Introduction To Information Systems (IS)** Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	2.1	**Data and Knowledge Management** Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management.	7
	2.2	**Business intelligence (BI)** Managers and Decision Making, BI for Data analysis and Presenting Results	
03	3.1	**Ethical issues and Privacy** Information Security. Threat to IS, and Security Controls	7
04	4.1	**Social Computing (SC)** Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	5.1	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	6.1	**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 life cycle models.	8

Text Book & References:	
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, Prentice Hall,2008

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Course Code	Course Name	Credits
ILO7014	**Design of Experiments**	**03**

Course Objectives:	
1	To understand the issues and principles of Design of Experiments (DOE)
2	To list the guidelines for designing experiments
3	To become familiar with methodologies that can be used in conjunction with experimental designs forrobustness and optimization

Course Outcomes:	
1	Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2	Apply the methods taught to real life situations
3	Plan, analyze, and interpret the results of experiments

Module		Contents	Hours
01	1.1	Introduction Strategy of Experimentation, Typical Applications of Experimental Design Guidelines for Designing Experiments Response Surface Methodology	06
02	2.1	Fitting Regression Models Linear Regression Models, Estimation of the Parameters in Linear Regression, Models Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple RegressionPrediction of new response observation, Regression model diagnostics, Testing for lack of fit	08
03	3.1	Two-Level Factorial Designs The 2^2 Design, The 2^3 Design, The General2^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	07
04	4.1	Two-Level Fractional Factorial Designs 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	07
05	5.1	Response Surface Methods and Designs Introduction to Response Surface MethodologyThe Method of Steepest Ascent Analysis of a Second-Order Response Surface Experimental Designs for Fitting Response Surfaces	07
06	6.1	**Taguchi Approach** Crossed Array Designs and Signal-to-Noise , Ratios Analysis Methods, Robust design examples	04

Text Book & References:	
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 E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design,Innovation and Discovery, 2nd Ed. Wiley

4	W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc.ISBN: 0-471-39054-2
5	Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean,and

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Course Code	Course Name	Credits
ILO7015	Operations Research	03

Course Objectives:	
1	Formulate a real-world problem as a mathematical programming model.
2	Understand the mathematical tools that are needed to solve optimization problems.
3	Use mathematical software to solve the proposed models.
Course Outcomes:	
1	Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2	Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3	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.
4	Understand the applications of integer programming and a queuing model and compute important performance measures

Module		Contents	Hrs
01	1.1	**Introduction to Operations Research** Introduction, Structure of the Mathematical Model, Limitations of Operations Research	14
	1.2	**Linear Programming** Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis	
	1.3	**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.	
	1.4	**Assignment Problem** Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem	
	1.5	**Integer Programming Problem** Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02	2.1	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05

03	3.1	**Simulation** Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	4.1	**Dynamic programming** Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	5.1	**Game Theory** Competitive games, 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 strategyfor 2 X 2 games.	05
06	6.1	**Inventory Models** Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Text Book & References:	
1	Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2	Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", JohnWilley and Sons, 2nd Edition, 2009.
3	Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4	Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5	Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

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Course Code	Course Name	Credits
ILO7016	**Cyber Security and Laws**	**03**

Course Objectives:
1	To understand and identify different types cybercrime and cyber law
2	To recognized Indian IT Act 2008 and its latest amendments
3	To learn various types of security standards compliances

Course Outcomes:
1	Understand the concept of cybercrime and its effect on outside world
2	Interpret and apply IT law in various legal issues
3	Distinguish different aspects of cyber law
4	Apply Information Security Standards compliance during software design and development

Module		Contents	Hrs
01	1.1	**Introduction to Cybercrime** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and theIndian ITA 2000, A global Perspective on cybercrimes.	4
02	2.1	**Cyber offenses & Cybercrime** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Bot nets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	3.1	**Tools and Methods Used in Cyber line** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	4.1	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of CyberLaw ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, GlobalTrends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian CyberLaw	8
05	5.1	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the ITAct, 2000, IT Act. 2008 and its Amendments	6
06	6.1	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

	Text Book & References:
1	Nina Godbole, Sunit Belapure, *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 Assurance* Information 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

Assessment:
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Course Code	Course Name	Credits
ILO7017	Disaster Management and Mitigation Measures	03

Course Objectives:	
1	To understand physics and various types of disaster occurring around the world
2	To identify extent and damaging capacity of a disaster
3	To study and understand the means of losses and methods to overcome /minimize it.
4	To understand role of individual and various organization during and after disaster
5	To understand application of GIS in the field of disaster management
6	To understand the emergency government response structures before, during and afterdisaster

Course Outcomes:	
1	Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2	Plan of national importance structures based upon the previous history.
3	Get acquainted with government policies, acts and various organizational structureassociated with an emergency.
4	Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module		Contents	Hours
01	1.1	**Introduction** Definition of Disaster, hazard, global and Indian scenario, 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.	03
02	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	09
	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 manmade disasters.	
03	3.1	**Disaster management** Meaning, concept, importance, objective of disastermanagement policy, disaster risks in India, Paradigm shift in disaster management.	06
	3.2	**Policy and administration** Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entireprocess.	
04	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	06

		of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.	
	4.2	Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	
05	5.1	**Financing Relief Measures** Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrenceof various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.	09
06	6.1	**Preventive and Mitigation Measures** Pre-disaster, during disaster and post-disaster measures in some events in general Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments,Bio shield, shelters, early warning and communication	06
	6.2	**Non Structural Mitigation** Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.	

	Text Book & References:
1	'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2	'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3	'Introduction to International Disaster Management' by Damon Copolla, Butterworth HeinemannElseveir Publications.
4	'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5	'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6	'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7	Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications. (Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Assessment:	
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Course Code	Course Name	Credits
ILO7018	Energy Audit and Management	03

Course Objectives:	
1	To understand the importance energy security for sustainable development and thefundamentals of energy conservation.
2	To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3	To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Course Outcomes:	
1	To identify and describe present state of energy security and its importance.
2	To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3	To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4	To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5	To analyze the data collected during performance evaluation and recommend energy savingmeasures

Module		Detailed Contents	Hours
01	1.1	**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	04
02	2.1	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, 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.	08
	2.2	**Financial analysis techniques:** Simple payback period, NPV, Return on investment (ROI),Internal rate of return (IRR)	
03	3.1	**Energy Management and Energy Conservation in Electrical System** Electricitybilling, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings.	10
	3.2	**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.	
04	4.1	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation 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.	10
05	5.1	**Energy Performance Assessment** On site Performance evaluation techniques, Case studies based on: Motors and variablespeed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	6.1	**Energy conservation in Buildings** Energy Conservation Building Codes (ECBC): Green Building, LEED rating,Application of Non-Conventional and Renewable Energy Sources	03

Text Book & References:	
1	Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2	Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3	Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4	Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata EnergyResearch 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, CRC Press
8	www.energymanagertraining.com
9	www.bee-india.nic.in

Assessment:	
Internal Assessment:	
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Course Code	Course Name	Credits
ILO7019	**Development Engineering**	03

Course Objectives:	
1	To familiarise the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2	To provide an exposure to implications of 73rdCAA on Planning, Development and Governance of RuralAreas
3	An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4	To familiarise the Nature and Type of Human Values relevant to Planning Institutions

Course Outcomes:	
1	Demonstrate understanding of knowledge for Rural Development.
2	Prepare solutions for Management Issues.
3	Take up Initiatives and design Strategies to complete the task
4	Develop acumen for higher education and research.
5	Demonstrate the art of working in group of different nature
6	Develop confidence to take up rural project activities independently

Module			Contents	Hrs
1	1.1		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.	**08**
2	2.1		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.	**06**
3	3.1		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; Specialcomponent plan and sub-plan for the weaker section; Micro-eco zones; Data base for localplanning; Need for decentralized planning; Sustainable rural development	**07**

4	4.1	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XIschedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalizedPanchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
5	5.1	Values and Science and Technology Material development and its values; the challenge of science 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 andethical 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	10
6	6.1	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Text Book & References:

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
9	How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150
10	Watson, V. Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theoryand Practice, Vol. 4, No.4, pp.395 – 407

Assessment:	
Internal Assessment:	
Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)	
End Semester Theory Examination: Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papersof end semester examination. **In question paper weightage of each module will be proportional to number ofrespective lecture hours as mention in the syllabus.**	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus

Lab Code	Lab Name	Credit
CSL701	**Deep Learning Lab**	**1**

Prerequisite: Python Programming, Engineering Mathematics

Lab Objectives:	
1	To implement basic neural network models.
2	To implement various training algorithms for feedforward neural networks.
3	To design deep learning models for supervised, unsupervised and sequence learning.

Lab Outcomes: At the end of the course, the students will be able to	
1	Implement basic neural network models.
2	Design and train feedforward neural networks using various learning algorithms and optimize model performance.
3	Build and train deep learning models such as Autoencoders, CNNs, RNN, LSTM,GRU etc.

Suggested List of Experiments	
1.	**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.
2	**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.

3.	**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.
4	**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 modelling etc.

	Textbooks:
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville. ―Deep Learning‖, MIT Press Ltd, 2016
2	Li Deng and Dong Yu, ―Deep Learning Methods and Applications‖, Publishers Inc.
3	Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4	JM Zurada ―Introduction to Artificial Neural Systems‖, Jaico Publishing House
5	M. J. Kochenderfer, Tim A. Wheeler. ―Algorithms for Optimization‖, MIT Press.
	References:
1	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
	Web 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

	Term Work:
1	Term work should consist of 8 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignment: 05-marks)
	Practical and Oral exam
	Oral examination based on the entire syllabus of CSC:701

Course Code	Course Name	Credits
CSL702	**Big Data Analytics Lab**	1

Prerequisite: Java/Python	
Lab Objectives:	
1	To provide an overview of an exciting growing field of big data analytics.
2	To introduce programming skills to build simple solutions using big data technologies such as MapReduce and scripting for NoSQL, and the ability to write parallel algorithms for multiprocessor execution.
3	To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4	To enable students to have skills that will help them to solve complex real-world problems in decision support.
Lab Outcomes:	
1	Understand the key issues in big data management and its associated applications for business decisions and strategy.
2	Develop problem solving and critical thinking skills in fundamental enabling techniques like Hadoop, Map reduce and NoSQL in big data analytics.
3	Collect, manage, store, query and analyze various forms of Big Data.
4	Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
5	Adapt adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.
6	Solve Complex real world problems in various applications like recommender systems, social media applications, health and medical systems, etc.

Suggested Experiments:

Sr. No.	Name of the Experiment
1	Hadoop HDFS Practical: -HDFS Basics, Hadoop Ecosystem Tools Overview. -Installing Hadoop. -Copying File to Hadoop. -Copy from Hadoop File system and deleting file. -Moving and displaying files in HDFS. -Programming exercises on Hadoop.
2	Use of Sqoop tool to transfer data between Hadoop and relational database servers. a. Sqoop - Installation. b. To execute basic commands of Hadoop 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.
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.

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/

Term Work:	
1	Term work should consist of 10 experiments
2	Journal must include at least 2 assignments based on Theory and Practical's
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam:	
	Oral examination based on the entire syllabus of CSC702 and CSL702

Course Code:	Course Title	Credit
CSDOL7011	**Natural Language Processing Lab**	1

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

Suggested Experiments:	
Sr. No.	**Name of the Experiment**
1	Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications: [Machine Translation, Text Categorization, Text summarization, Chat Bot, Plagiarism, Spelling & Grammar Checkers, Sentiment / Opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.]

2	Apply various 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

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

Term Work:	
1	Term work should consist of 08 experiments and mini project
2	Journal must include at least 2 assignments based on Theory and Practical's

3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Course Code:	Course Title	Credit
CSDOL7012	AI for Healthcare Lab	1

Prerequisites: Python

Lab Objective

1	To Collect, clean, integrate, and transform healthcare data for a specific disease.
2	To Perform exploratory data analysis on healthcare data.
3	To Develop AI models for medical diagnosis using MRI/X-ray data.
4	To Build AI models for medical prognosis.
5	Extract entities from medical reports using natural language processing.
6	To Predict disease risk using patient data

Lab Outcomes:

After successful completion of the course, the student will be able to:

1	Understand computational models of AI ,
2	Develop healthcare applications using appropriate computational tools.
3	Apply appropriate models to solve specific healthcare problems.
4	Analyze and justify the performance of specific models as applied to healthcare problems.
5	Design and implement AI based healthcare applications.

Suggested Experiments:

Sr. No.	Name of the 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 application using Healthcare Data. (this needs to be implemented in group of 3-4 students)
10	Documentation and Presentation of Mini Project.

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 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

Useful Links	
1	https://www.coursera.org/learn/introduction-tensorflow?specialization=tensorflow-in-practice
2	https://www.coursera.org/learn/convolutional-neural-networks-tensorflow?specialization=tensorflo w- in-practice
3	https://datarade.ai/data-categories/electronic-health-record-ehr-data
4	https://www.cms.gov/Medicare/E-Health/EHealthRecords
5	https://www.coursera.org/learn/tensorflow-sequences-time-series-and-prediction?specialization=te nsorflow-in-practice

Term Work:	
1	Term work should consist of 8 experiments and a Mini Project.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 10-Marks, Mini Project-10 Marks, Attendance Theory & Practical: 05 marks)

Course Code:	Course Title	Credit
CSDOL7013	**Neural Networks and Fuzzy Systems Lab**	1

Prerequisite: C/C++/Java/MATLAB
Lab Objectives:
1	Articulate basic knowledge of fuzzy set theory through programing.
2	To design Associative Memory Networks.
3	To apply Unsupervised learning towards Networks design.
4	To demonstrate Special networks and its applications in soft computing.
5	To implement Hybrid computing systems.
Lab Outcomes: At the end of the course, the students will be able to
1	Implement Fuzzy operations and functions towards Fuzzy-rule creations.
2	Build and training Associative Memory Network.
3	Build Unsupervised learning based networks .
4	Design and implement architecture of Special Networks
5	Implement Neuro-Fuzzy hybrid computing applications.

Suggested Experiments:	
Sr. No.	**Name of the 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).
5	Implement any De-fuzzification of membership method.
6	Implement Bidirectional Associative Memory(BAM) Network
7	Implement Radial basis function network.
8	Implement Basic Neural Network learning rules.
9	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.

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/

Term Work:	
1	Term work should consist of 08 experiments, 1 case study.
2	Journal must include at least 2 assignments based on Theory and Practical's.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Course Code:	Course Title	Credit
CSDOL7021	User Experience Design with VR Lab	1

Prerequisite: Computer Graphics, Python
Lab Objectives:

1	To perform installation of Unity
2	To explore working of VR Gadget
3	To develop scene VR application
4	To track objects in virtual environment

Lab Outcomes:

1	Setup VR development environment
2	Use HTC Vive/ Google Cardboard/ Google Daydream and Samsung gear VR.
3	Develop VR scene and place object
4	Identify, examine and develop software that reflects fundamental techniques for the design and deployment of VR experiences

Suggested Experiments:

Sr. No.	Name of the Experiment
1	Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
2	Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
3	Develop a scene in Unity that includes: i. a cube, plane and sphere, apply transformations on the 3 game objects. ii. add a video and audio source
4	Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects. Change the colour, material and texture of

		each Game object separately in the scene. Write a C# program in visual studio to change the colour and material/texture of the game objects dynamically on button click
	5	Develop a scene in Unity that includes a sphere and plane . Apply Rigid body component, material and Box collider to the game Objects. Write a C# program to grab and throw the sphere using vr controller.
	6	Develop a simple UI(User interface) menu with images, canvas, sprites and button. 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	Create 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 Assignment 7.
	9	Case 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

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

Term Work:	
1	Term work should consist of 08 experiments and mini project
2	Journal must include at least 2 assignments based on Theory and Practical's

3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Course Code:	Course Title	Credit
CSDOL7022	**Blockchain Technologies Lab**	**1**

Prerequisite: Java, Python, JavaScript.

Lab Objectives:

1	To develop and deploy smart contracts on local Blockchain.
2	To deploy the smart contract on test networks.
3	To deploy and publish smart contracts on Ethereum test network.
4	To design and develop crypto currency.
5	To deploy chain code on permissioned Blockchain.
6	To design and develop a Full-fledged DApp using Ethereum/Hyperledger.

Lab Outcomes:

1	Develop and test smart contract on local Blockchain.
2	Develop and test smart contract on Ethereum test networks.
3	Write and deploy smart contract using Remix IDE and Metamask.
4	Design and develop Cryptocurrency.
5	Write and deploy chain code in Hyperledger Fabric.
6	Develop and test a Full-fledged DApp using Ethereum/Hyperledger.

Suggested Experiments:

Sr. No.	Name of the 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

Text Books:

1. Ethereum Smart Contract Development, Mayukh Mukhopadhyay, Packt publication.
2. Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Ritesh Modi, Packt publication.
3. Hands-on Smart Contract Development with Hyperledger Fabric V2, Matt Zand, Xun Wu and Mark 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 Solution, Technology/platform used)
5. Chapter-2 (System design/Block diagram, Flow chart, Software requirements, cost estimation)
6. Chapter-3 (Implementation snapshots/figures with explanation, code, future directions)
7. Chapter-4 (Conclusion)
8. References

Useful Links	
1	https://trufflesuite.com/
2	https://metamask.io/
3	https://remix.ethereum.org/
4	https://www.hyperledger.org/use/fabric

Term Work:	
1	Term work should consist of 08 experiments and mini project
2	Journal must include at least 2 assignments based on Theory and Practical's
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Course Code:	Course Title	Credit
CSDOL7023	**Game Theory for Data Science LAB**	**1**

Prerequisite: Probability, Algebra

Lab Objectives:	
1	To understand fundamental game theory concepts.
2	To apply game theory to real-world data science scenarios.
3	To analyze Nash equilibria in different types of games.
4	To investigate mixed strategies and their implications.
5	To learn game theory algorithms and computational tools.
6	To explore applications of game theory in data science.

Lab Outcomes:	Learner will be able to
1	Gain a solid understanding of fundamental game theory concepts.
2	Develop the ability to apply game theory principles to real-world data science problems.
3	Analyze and identify Nash equilibria in various game scenarios.
4	Comprehend the implications and applications of mixed strategies in game theory.
5	Acquire practical skills in utilizing game theory algorithms and computational tools.
6	Explore and appreciate the wide range of applications of game theory in data science.

Suggested 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)

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 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.

Digital References:

1. https://nptel.ac.in/courses/110104063

2. https://onlinecourses.nptel.ac.in/noc19_ge32/preview

Term Work:

1. Term work should consist of 10 experiments.
2. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

4. Total 25 Marks: Experiments- 15-marks, Attendance Theory & Practical: 05-marks, Assignment: 05-marks.

Course Code:	Course Title	Credit
CSP701	**Major Project 1**	**3**

	Course Objectives:
1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.

	Course Outcomes:
1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group
3	Draw the proper inferences from available results through theoretical/ experimental/simulations
4	Analyse the impact of solutions in societal and environmental context for sustainable development.
5	Demonstrate capabilities of self-learning in a group, which leads to life long learning.
6	Demonstrate project management principles during project work.

Guidelines:

1. Project Topic Selection and Allocation:

- Project topic selection Process to be defined and followed:
    - Project orientation can be given at the end of sixth semester.
    - Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
    - Student's should be recommended to refer papers from reputed conferences/journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
    - Dataset selected for the project should be large and realtime
    - 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 Digital India portal, SIH portal or any other hackathon portal forproblem 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 decision regarding final selection of projects.
- Guide allocation should be done and students have to submit weekly progress report to the internal guide.
- 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.
- In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels

2. Project Report Format:

At the end of semester, each group needs to prepare a project report as per the guidelines issued 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

Desirable

Students can be asked to undergo some Certification course (for the technical skill set thatwill be useful and applicable for projects.)

3. Term Work:

Distribution of marks for term work shall be done based on following:

- o Weekly Log Report
- o Project Work Contribution
- o Project Report (Spiral Bound) (both side print)
- o Term End Presentation (Internal)

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

4. Oral and Practical:

Oral and Practical examination (Final Project Evaluation) of Project 1 should be conducted byInternal and External examiners approved by University of Mumbai at the end of the semester.

Suggested quality evaluation parameters are as follows:

- o Quality of problem selected
- o Clarity of problem definition and feasibility of problem solution
- o Relevance to the specialization / industrial trends
- o Originality
- o Clarity of objective and scope
- o Quality of analysis and design
- o Quality of written and oral presentation
- o Individual as well as teamwork

Course Code	Course Title	Credit
CSC801	**Advanced Artificial Intelligence**	3

Prerequisite: Engineering Mathematics, Data Structures and Algorithm, Python Programming	

Course Objectives:

1	To relate with the basic concepts of Probabilistic Models.
2	To understand the scope of Generative Networks in the field of AI.
3	To recognize various components of Autoencoder Architecture and Training process.
4	To learn the fundamentals of Transfer Learning.
5	Provide students with a comprehensive understanding of ensemble methods and their applications.
6	To explore the nascent applications of AI

Course Outcomes: After successful completion of the course student will be able to

1	Acquire basic knowledge of Probabilistic Models.
2	Analyze the working and architecture for Generative Networks.
3	Interpret various components and various types of Autoencoders
4	Understand various aspects of Transfer Learning.
5	Apply ensemble learning techniques to real-world problems and demonstrate improved predictive performance.
6	Relate to the nascent technologies in the field of artificial intelligence.

Module		Content	Hrs
1.0		**Generative and Probabilistic Models**	**08**
	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.	
2.0		**Generative Adversarial Network**	**07**
	2.1	**Basics of GAN :** Generative Adversarial Networks (GANs) architecture, The discriminator model and generator model, Architecture and Training of GANs, Vanilla GAN Architecture. GAN variants and improvements (DCGAN,WGAN, Conditional GAN, CycleGAN), Challenges- Training instability and model collapse, GAN applications in image synthesis and style transfer.	
3.0		**Variational Autoencoders**	**07**

	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)	
4.0		**Transfer Learning**	**05**
	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.	
5.0		**Ensemble learning**	**06**
	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.	
6.0		**Nascent Technologies in AI**	**06**
	6.1	**Ensemble Classifiers**: 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 paradigms.	

Textbooks:	
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.

References:	
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. |

Digital References:

https://nptel.ac.in/courses/106106201

https://onlinecourses.nptel.ac.in/noc20_cs62/preview

https://machinelearningmastery.com/what-are-generative-adversarial-networks-gans/

<u>**Assessment**</u>**:**

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code	Course Name	Total
CSDO8011	**AI for financial & Banking application**	03

Course Objectives:

Course Objectives	
1	To understand the impact of technology and digitization on financial and bankingenterprises.
2	To explore blockchain technologies in the financial sector.
3	To examine digital money transfer mechanisms and GIFT cities.
4	To evaluate the benefits of digitization and cloud services in banking.
5	To analyze enterprise software solutions for financial operations.
6	To study the integration of AI in banking processes

Course Outcomes	
On successful completion, of course, learner/student will be able to:	
1	Gain knowledge of technology's influence on financial and banking enterprises.
2	Understand the applications of blockchain in the financial sector.
3	Recognize digital money transfer mechanisms and its role in digitization
4	Evaluate the advantages of digitization and cloud services in banking.
5	Analyze enterprise software solutions for financial operations.
6	Explore the integration of AI in banking processes.

Sr. No.	Module	Detailed Content	Hours
1		**Information TechnologyInfrastructure and Digitization of Financial Banking Enterprises**	**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 A 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-neutra enterprises.	
2		**Financial Statistics andThe Sharpe Ratio**	**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 Mode ,Sharpe Ratio Formula, Time Periods and Annualizing, Ranking Investmen Candidates, The Quant mod Package, Measuring Income Statemen Growth, Sharpe Ratios for Income Statement Growth	

3		**Cluster Analysis**	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**	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 Agorithms**	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**	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	

	Textbooks:
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

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

Digital 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

Assessment:
Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

	End Semester Theory Examination:
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code	Course Title	Credit
CSDO8012	Quantum Computing	3

Prerequisite: Engineering Mathematics, Data Structures and Algorithm, Python Programming	

Course Objectives:

1	To understand basics of quantum computing
2	To understand mathematics required for quantum computing
3	To understand building blocks of quantum computing and design algorithms
4	To understand quantum hardware principles and tools for quantum computing.

Course Outcomes: After successful completion of the course student will be able to

1	Understand basic concepts of quantum computing
2	Illustrate building blocks of quantum computing through architecture and programming models.
3	Appraise various mathematical models required for quantum computing
4	Discuss various quantum hardware building principles.
5	Identify the various quantum algorithms
6	Describe usage of tools for quantum computing.

Module		Content	Hrs
1.0		Introduction to Quantum Computing	**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.)	
2.0		Mathematical Foundations for Quantum Computing	**05**
	2.1	Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.	
3.0		Building Blocks for Quantum Program	**08**

	3.1	Architecture of a Quantum Computing platform Details of q-bit system of information representation: Block Sphere Multi-qubits States Quantum superposition of qubits (valid and invalid superposition) Quantum Entanglement Useful states from quantum algorithmic 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.	
4.0		Quantum Algorithms and Error correction	**06**
	4.1	Quantum Algorithms, Shor's Algorithm, Grover's Algorithm. Deutsch's Algorithm, Deutsch -Jozsa Algorithm	
	4.2	Quantum error correction using repetition codes 3 qubit codes, Shor's 9 qubit error correction Code	
5.0		Quantum Hardware	**10**
	5.1 **5.2** **5.3** **5.4**	Ion Trap Qubits ,The DiVincenzo Criteria , Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating Rotor Quantum Mechanics of a Free Rotor: A Poor Person's Atomic 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 .. 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 in quantum dots, A 2-qubit spintronic universal quantum gate.	
6.0		OSS Toolkits for implementing Quantum program	**03**
	6.1	IBM quantum experience Microsoft Q Rigetti PyQuil (QPU/QVM)	

	Textbooks:
1	Michael A. Nielsen, ―Quantum Computation and Quantum Information‖, Cambridge University Press.
2	David McMahon, ―Quantum Computing Explained‖, Wiley ,2008
3	Qiskit textbook https://qiskit.org/textbook-beta/
4	Vladimir Silva, Practical Quantum Computing for Developers,2018

References:	
1	Bernard Zygelman, A First Introduction to Quantum Computing and Information,2018
2	Supriyo Bandopadhyay and Marc Cahy, ―Introduction to Spintronics‖, CRC Press, 2008
3	The Second Quantum Revolution: From Entanglement to Quantum Computing and Other Super-Technologies, Lars Jaeger
4	La Guardia, Giuliano Gladioli ―Quantum Error correction codes‖Springer,2021

Digital References:
https://onlinecourses.nptel.ac.in/noc21_cs103/preview
https://www.coursera.org/courses?query=quantum%20computing
https://www.cl.cam.ac.uk/teaching/1617/QuantComp/

Course Code:	Course Title	Credit
CSDO8013	**Reinforcement Learning**	**3**

Prerequisite: Probability distributions and expected values, and basic linear algebra
Course Objectives:

1	Define the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning.
2	Introduction to statistical learning techniques where an agent explicitly takes actions and interacts with the world.
3	Implement in code common RL algorithms.
4	Describe multiple criteria for analyzing RL algorithms & evaluate algorithms on these metrics: e.g. regret, Sample complexity, computational complexity, empirical performance, convergence, etc.
5	Know how to implement dynamic programming as an efficient solution approach to an industrial control problem.
6	Explore solutions to the Exploration-Exploitation Dilemma.

Course Outcomes:

1	Learn how to define RL tasks and the core principles behind the RL, including policies, value functions, deriving Bellman equations.
2	Evaluate work with tabular methods to solve classical control problems.
3	Apply Markov Decision Processes to solve real-world problems.
4	Understand the dynamic programming for policy Evaluation.
5	Implement reinforcement learning problems based on averaging sample returns using Monte Carlo method.
6	Recognize current advanced techniques and applications in RL.

Module		Content	Hrs
0		**Prerequisite**	**2**
		Probability distributions and expected values, and basiclinear algebra (e.g., inner products).	
1		**Introduction to Reinforcement Learning:**	**4**
	1.1	Reinforcement Learning: Key features and Elements of RL, Types of RL, rewards. Reinforcement LearningAlgorithms: Q-Learning, State Action Reward State action (SARSA).	
2		**Bandit problems And. online Learning**	**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**	**7**
	3.1	The Agent–Environment Interface, The Agent– Environment Interface, Goals and Rewards, Returns, Markov properties, Markov Decision Process, ValueFunctions and Optimal Value Functions,	
4		**Dynamic Programming**	**7**
	4.1	Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, Asynchronous DynamicProgramming, Generalized Policy Iteration	
5		**Monte Carlo Methodsand Temporal- Difference Learning**	**7**
	5.1	Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, TD Prediction, TDcontrol using Q-Learning	
6		**Applications and Case Studies**	**5**
	6.1	Elevator Dispatching, Dynamic Channel Allocation, Job-Shop Scheduling	

Textbooks:	
1	Reinforcement Learning: An Introduction, by Richard S. Sutton and Andrew G. Barto
2	Alessandro Palmas, Dr. Alexandra Galina Petre, Emanuele Ghelfi, The Reinforcement LearningWorkshop: 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.
References:	
1	Maxim Lapan, Deep Reinforcement Learning Hands-On: Apply modern RL methods, withdeep 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

Assessment:
Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.
End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus

Course Code	Course Name	Credit
CSDO8021	**Graph Data Science**	**03**

Sr. No	Course Objectives
1	To Understand the basics of graphs, including definitions, connectivity, and properties.
2	To Explore the use of graphs in solving puzzles and optimization problems.
3	To Learn about the advantages of graph databases over relational and NoSQL databases.
4	To Gain knowledge of data modeling with graphs, including the labeled property graph model.
5	To Develop skills in building graph database applications, including data modeling and testing.
6	To Explore real-world use cases and understand non-functional characteristics of graph databases.

Sr. No	Course Outcomes
On successful completion, of course, learner/student will be able to:	
1	Demonstrate a solid understanding of graph concepts and properties.
2	Apply graph algorithms to solve puzzles and optimization problems.
3	Compare graph databases with relational and NoSQL databases.
4	Model data using the labeled property graph model and avoid common pitfalls.
5	Build graph database applications with proper data modeling and testing.
6	Analyze and implement graph database solutions for real-world use cases, considering non-functional characteristics

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1		**Introduction to Graph**	**4**
	1.2	Definitions and examples, Three puzzles, Paths and cycles, Connectivity, Eulerian graphs, Hamiltoniangraphs, shortest path, Chinese postman problem, travelingsalesman problem, trees, properties of trees	
2		**Introduction Graph Databases**	**7**
	2.1	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 LackRelationships, Graph databases embraces relationship	
3		**Data Modelling with Graphs**	**7**
	3.1	Models and Goals, The Labelled Property Graph Mode Querying Graphs, A Comparison of Relational and GraphModelling, Cross-Domain Models, Common Modelling Pitfalls, Identifying Nodes and Relationships, Avoiding Anti-Patterns	
4		**Building a Graph Database Application**	**7**
	4.1	Data Modelling , Application Architecture ,Testing, Capacity Planning, Importing and Bulk Loading Data .	
5		**Graphs in the Real World**	**7**
	5.1	Organizations Choose Graph Databases, Common Use Cases, Real-World Examples, Authorization and Acces Control, Geospatial and Logistics, Graph Database Internals, Native Graph Processing, Native Graph StorageProgrammatic APIs, Kernel API, Core API, Traversa Framework, Non-functional Characteristics	
6		**Case Study**	**7**

| | 6.1 | Neo4j – About, Neo4j – Installation, Neo4j – Browser Neo4j - Query Language (Cypher) , Neo4j – Create a NodeNeo4j - 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 | |

Textbooks:	
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

References:	
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.

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

Assessment:
Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code:	Course Title	Credit
CSDO8022	**Recommendation Systems**	**3**

Prerequisite: Artificial Intelligence and Machine Learning, Basic knowledge of Python
Course Objectives:
1	To introduce Recommendation systems and it's basic concepts.
2	To understand design and working of Collaborative Filtering based recommendation.
3	To analyze design and working of Content-based recommendation.
4	To understand design and working of Knowledge based recommendation.
5	To understand design and working of Ensembled- Based and Hybrid Recommendation Systems.
6	To identify the methods for evaluation of recommendation systems.
Course Outcomes: After successful completion of the course student will be able to
1	To have a broad understanding of the field of Recommendation Systems.
2	In-depth Knowledge of the architecture and models for Collaborative Filtering.
3	Understanding the architecture and working of Content based recommendation systems.
4	Understanding the architecture and basics of Knowledge based recommendation systems.
5	Analyzing hybrid and ensembles recommendation systems.
6	Evaluation of recommendation systems by selecting right evaluation parameter.

Module		Content	Hrs
1.0		**Introduction to Recommendation System**	**06**
	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.	
2.0		**Collaborative Filtering**	**06**
	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.	

3.0		**Content-based recommendation**	07
	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	
4.0		**Knowledge based recommendation**	06
	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.	
5.0		**Ensembled- Based and Hybrid Recommendation System**	06
	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.	
6.0		**Evaluating Recommendation System**	08
	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.	

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

1	http://www.iem.iitkgp.ac.in/eco/Recommender_Systems/
2	https://www.coursera.org/specializations/recommender-systems
3	https://www.udemy.com/course/recommender-systems/
4	https://www.analyticsvidhya.com/blog/2021/08/developing-a-course-recommender-system-using-python/

Assessment:
Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus

Course Code	Course Name	Credit
CSDO8023	**Social Media Analytics**	**03**

Prerequisite: Graph Theory, Data Mining, Python/R programming	

Course Objectives: The course aims:	
1	Familiarize the learners with the concept of social media.
2	Familiarize the learners with the concept of social media analytics and understand its significance.
3	Enable the learners to develop skills required for analyzing the effectiveness of social media.
4	Familiarize the learners with different tools of social media analytics.
5	Familiarize the learner with different visualization techniques for Social media analytics.
6	Examine the ethical and legal implications of leveraging social media data.

Course Outcomes:	
1	Understand the concept of Social media
2	Understand the concept of social media Analytics and its significance.
3	Learners will be able to analyze the effectiveness of social media
4	Learners will be able to use different Social media analytics tools effectively and efficiently.
5	Learners will be able to use different effective Visualization techniques to represent social media analytics.
6	Acquire the fundamental perspectives and hands-on skills needed to work with social media data.

Module		Content	Hours
1.		**Social Media Analytics: An Overview**	6
	1.1	Core Characteristics of Social Media, Types of Social Media, Social medialandscape, 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.	
2.		**Social Network Structure, Measures & Visualization**	6
	2.1	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 Networkfeatures, Scale Issues. Social Media Network Analytics - Common Network Terms,Common Social Media Network Types, Types of Networks, Common Network Terminologies, Network Analytics Tools.	
3.		**Social Media Text, Action & Hyperlink Analytics**	8
	3.1	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 Hyperlink Analytics, Hyperlink Analytics Tools	
4		**Social Media Location & Search Engine Analytics**	6
	4.1	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 EngineAnalytics, Search Engine Analytics Tools	
5		**Social Information Filtering**	6
	5.1	Social Information Filtering - Social Sharing and filtering , Automated Recommendation systems, Traditional Vs socialRecommendation Systems Understanding Social Media and Business Alignment, Social Media KPI,Formulating a Social Media Strategy, Managing Social Media Risks	
6		**Social Media Analytics Applications and Privacy**	7
	6.1	Social media in public sector - Analyzing public sector social media, analyzingindividual users, case study. Business use of Social Media - Measuring success, Interaction andmonitoring, case study. Privacy - Privacy policies, data ownership and maintaining privacyonline.	

Textbooks:	
1.	Seven Layers of Social Media Analytics_ Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data, Gohar F. Khan,(ISBN-10: 1507823207).
2.	Analyzing the Social Web 1st Edition by Jennifer Golbeck
3.	Mining the Social Web_ Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites, Matthew A Russell, O'Reilly
4	Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011

References:	
1.	Social Media Analytics [2015], Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, AvinashKohirkar, IBM Press
2.	Social Media Analytics Strategy_ Using Data to Optimize Business Performance, Alex Gonçalves, APress Business Team
3.	Social Media Data Mining and Analytics, Szabo, G., G. Polatkan, O. Boykin & A. Chalkiopoulus (2019), Wiley, ISBN 978-1-118-82485-6

Useful Links	
1	https://cse.iitkgp.ac.in/~pawang/courses/SC16.html
2	https://onlinecourses.nptel.ac.in/noc20_cs78/preview
3	https://nptel.ac.in/courses/106106146
4	https://7layersanalytics.com/

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40%syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
ILO8021	**Project Management**	**03**

Course Objectives:	
1	To familiarize the students with the use of a structured methodology/approach for each and everyunique project undertaken, including utilizing project management concepts, tools and techniques.
2	To appraise the students with the project management life cycle and make them knowledgeable aboutthe various phases from project initiation through closure.

Course Outcomes:	
1	Apply selection criteria and select an appropriate project from different options.
2	Write work break down structure for a project and develop a schedule based on it.
3	Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4	Use Earned value technique and determine & predict status of the project.
5	Capture lessons learned during project phases and document them for future reference

Module		Contents	Hours
1		**Project Management Foundation**	5
	1.1	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).	
2		**Initiating Projects**	6
	2.1	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.	
3		**Project Planning and Scheduling**	8
	3.1	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).	
4		**Planning Projects**	6
	4.1	Crashing project time, Resource loading and leveling, Goldratt's critical chain, ProjectWork Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk 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.	8
	5.2	**Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Usingmilestones for measurement; change requests and scope creep. Project audit.	
	5.3	**Project Contracting:** Project procurement management, contracting and outsourcing,	
	6.1	**Project Leadership and Ethics:**	

| 6 | | Introduction to project leadership, ethics in projects. Multicultural and virtual projects. | 6 |
| | 6.2 | **Closing the Project:** 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 | |

Textbooks & References	
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,ProjectManagement 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.

Internal Assessment:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1	Question paper will comprise of total six question
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8022	**Finance Management**	**03**

Course Objectives:	
1	Overview of Indian financial system, instruments and market
2	Basic concepts of value of money, returns and risks, corporate finance, working capital and itsmanagement
3	Knowledge about sources of finance, capital structure, dividend policy

Course Outcomes:	
1	Understand Indian finance system and corporate finance
2	Take investment, finance as well as dividend decisions

Module		Contents	Hours
1	1.1	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System.	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 StockExchanges	
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.	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.	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; LiquidityRatios; 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)	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.	5
	5.2	**Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of CapitalStructure 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.	3

Textbooks & References	
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 HillEducation, New Delhi
4	Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) &Company Limited, New Delhi.

Internal Assessment:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either aclass test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1	Question paper will comprise of total six question
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8023	**Entrepreneurship Development and Management**	**03**

	Course Objectives:
1	To acquaint with entrepreneurship and management of business
2	Understand Indian environment for entrepreneurship
3	Idea of EDP, MSME

	Course Outcomes:
1	Understand the concept of business plan and ownerships
2	Interpret key regulations and legal aspects of entrepreneurship in India
3	Understand government policies for entrepreneurs

Module		Detailed Contents	Hrs
1	1.1	**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	4
	1.2	**Role of Money and Capital Markets in Entrepreneurial Development** Contribution of Government Agencies in Sourcing information for Entrepreneurship	
2	2.1	**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	9
	2.2	**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	
3	3.1	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDPcell, role of sustainability and sustainable development for SMEs, case studies, exercises	5
4	4.1	**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.	8
5	5.1	**Effective Management of Business** Issues and problems faced by micro and smallenterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	8

6	6.1	**Achieving Success In The Small Business** Stages of the small business life cycle, fourtypes of firm-level growth strategies, Options- harvesting or closing small business Critical Success factors of small business		5

	Textbooks & References
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

Internal Assessment:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either aclass test or assignment on live problems or course project.

End Semester Theory Examination:	
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**	
1	Question paper will comprise of total six question
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8024	**Human Resource Management**	**03**

Course Objectives:

1	To introduce the students with basic concepts, techniques and practices of the human resource management.
2	To provide opportunity of learning Human resource management (HRM) processes, related with thefunctions, and challenges in the emerging perspective of today's organizations.
3	To familiarize the students about the latest developments, trends & different aspects of HRM.
4	To acquaint the student with the importance of inter-personal & inter-group behavioral skills in anorganizational setting required for future stable engineers, leaders and managers.

Course Outcomes:

1	Understand the concepts, aspects, techniques and practices of the human resource management.
2	Understand the Human resource management (HRM) processes, functions, changes and challenges intoday's emerging organizational perspective.
3	Gain knowledge about the latest developments and trends inHRM.
4	Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroupenvironment emerging as future stable engineers and managers.

Module		Contents	Hours
1	1.1	**Introduction to HR** Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring andrightsizing,Empowerment, TQM, Managing ethical issues.	5
2		**Organizational Behavior (OB)**	
	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 forIncreasing Self Awareness	
	2.3	**Perception:** Attitude and Value, Effect of perception on IndividualDecision-making, Attitude and Behavior.	7
	2.4	**Motivation:** Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);	
	2.5	**Group Behavior and Group Dynamics:** Work groups formal and informal groups and stages of group development. Team Effectiveness: High performingteams, Team Roles, cross functional and self-directed team. Case study	
3		**Organizational Structure &Design**	6
	3.1	Structure, size, technology, Environment of organization; Organizational Roles& conflicts: Concept of roles; role dynamics; role conflicts and stress.	
	3.2	**Leadership:** Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.	
	3.3	**Power and Politics:** Sources and uses of power; Politics atworkplace, Tactics and strategies.	

4	4.1	**Human resource Planning** Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.	5
	4.2	**Performance Appraisal Systems:** Traditional & modern methods, Performance Counseling, Career Planning.	
	4.3	**Training & Development:** Identification of Training Needs, TrainingMethods	
5		**Emerging Trends in HR**	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	6.1	**HR & MIS** 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	10
	6.2	**Strategic HRM** 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	

Textbooks & References

1	Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2	V S P Rao, Human Resource Management, 3rd Ed, 2010, Excelpublishing
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

Internal Assessment:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either aclass test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1	Question paper will comprise of total six question
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)	03

Course Objectives:

1	To understand professional ethics in business
2	To recognized corporate social responsibility

Course Outcomes:

1	Understand rights and duties of business
2	Distinguish different aspects of corporate social responsibility
3	Demonstrate professional ethics
4	Understand legal aspects of corporate social responsibility

Module		Contents	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	4
2	2.1	**Professional Ethics in the Marketplace** Perfect Competition; Monopol Competition; Oligopolistic Competition; Oligopolies and Public Policy	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	6
	3.2	**Professional Ethics of Job Discrimination** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	
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	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 India	8
6	6.1	**Corporate Social Responsibility in Globalizing India** Corporate Social ResponsibilityVoluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	8

	Textbooks & References
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 Bidyut Chakrabarty, Routledge, New Delhi.

Internal Assessment:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either aclass test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1	Question paper will comprise of total six question
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8026	**Research Methodology**	**03**

	Course Objectives:
1	To understand Research and Research Process
2	To acquaint students with identifying problems for research and develop research strategies
3	To familiarize students with the techniques of data collection, analysis of data and interpretation

	Course Outcomes:
1	Prepare a preliminary research design for projects in their subject matter areas
2	Accurately collect, analyze and report data
3	Present complex data or situations clearly
4	Review and analyze research findings

Module		Contents	Hours
01	1.1	**Introduction and Basic Research Concepts** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis,Law, Principle. Research methods vs Methodology. Need of Research in Business and Social SciencesObjectives of Research Issues and Problems in Research Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	9
02	2.1	**Types of Research** Basic Research, Applied Research, Descriptive Research, Analytical Research, Empirical Research, Qualitative and Quantitative Approaches	7
03	3.1	**Research Design and Sample Design** Research Design – Meaning, Types and Significance. Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	7
04	4.1 4.2	**Research Methodology** **Meaning of Research Methodology** **Stages in Scientific Research Process** Identification and Selection of Research Problem, Formulation of Research Problem, Review of Literature, Formulation of Hypothesis Formulation of research Design, Sample Design, Data Collection, Data Analysis, Hypothesis testing and Interpretation of Data, Preparation of Research Report	8
05	5.1	**Formulating Research Problem** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis ofdata, Generalization and Interpretation of analysis.	4
06	6.1	**Outcome of Research** Preparation of the report on conclusion reachedValidity Testing & Ethical Issues Suggestions and Recommendation	4

	Textbooks & References
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

Internal Assessment:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1	Question paper will comprise of total six question
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Course Objectives:	
1	To understand intellectual property rights protection system
2	To promote the knowledge of Intellectual Property Laws of India as well as International treatyprocedures
3	To get acquaintance with Patent search and patent filing procedure and applications

Course Outcomes:	
1	Understand Intellectual Property assets
2	Assist individuals and organizations in capacity building
3	Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module		Detailed Contents	Hr
01	1.1	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different categories of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc.	05
	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.	
02	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	07
	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.	
03	3.1	**Emerging Issues in IPR** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	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 of getting a patent.	07

	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.)	08
05			
06	6.1	**Procedure for Filing a Patent (National and International)** Legislation and SalientFeatures, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement.	07
	6.2	**Patent databases** Important websites, Searching international databases	

Textbooks & References	
1	Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, TheInstitute 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 Trendsand 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	Lous Harns, 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, Intellactual Property Law for Engineers and scientists, Wiley-IEEE Press

Internal Assessment:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either aclass test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1	Question paper will comprise of total six question
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8028	**Digital Business Management**	**03**

Course Objectives:	
1	To familiarize with digital business concept
2	To acquaint with E-commerce
3	To give insights into E-business and its strategies

Course Outcomes:	
1	Identify drivers of digital business
2	Illustrate various approaches and techniques for E-business and management
3	Prepare E-business plan

Module		**Content**	**Hours**
01	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,	09
	1.2	**Drivers of digital business** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent machines/services) Opportunities and Challenges in Digital Business.	
02	2.1	**Overview of E-Commerce** E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, 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 Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing	06
	2.2	**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 andSocietal impacts of EC	
03	3.1	**Digital Business Support services** ERP as e –business backbone, knowledgeTope Apps, Information and referral system	06
	3.2	**Application Development:** Building Digital Business Applications and Infrastructure	

04	4.1	**Managing E-Business** Managing Knowledge, Management skills for e-business, Managing Risks in e –business	
	4.2	**Security Threats to e-business** Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, DigitalSignatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
05	5.1	**E-Business Strategy** E-business Strategic formulation- Analysis ofCompany's Internal and external environment, Selection of strategy, E- business strategy into Action, challenges and E-Transition (Process ofDigital Transformation)	04
06	6.1	**Materializing e-business:** From Idea to Realization Business plan preparation	08
	6.2	**Case Studies and presentations**	

	Textbooks & References
1	A textbook on E-commerce**,** Er Arunrajan 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 andpractice 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

Internal Assessment:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1	Question paper will comprise of total six question
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8029	**Environmental Management**	**03**

Course Objectives:	
1	Understand and identify environmental issues relevant to India and global concerns
2	Learn concepts of ecology
3	Familiarise environment related legislations
Course Outcomes:	
1	Understand the concept of environmental management
2	Understand ecosystem and interdependence, food chain etc.
3	Understand and interpret environment related legislations

Module		Detailed Contents	Hrs
01	1.1	**Introduction and Definition of Environment** Significance of EnvironmentManagement for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energyscenario.	10
02	2.1	**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.	06
03	3.1	**Concepts of Ecology** Ecosystems and interdependence between livingorganisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	4.1	Scope of Environment Management, Role & functions of Government as a planningand regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	5.1	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	6.1	General overview of major legislations like Environment Protection Act, Air (P & CP)Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Textbooks & References	
1	Environmental Management: Principles and Practice, C J Barrow, Routledge PublishersLondon, 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
Internal Assessment:	
Assessment consists of two tests out of which; one should be compulsory class test and the other is either aclass test or assignment on live problems or course project.	

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1	Question paper will comprise of total six question
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.

Course Code:	Course Title	Credit
CSL801	Advanced AI Lab	01

Prerequisite: Python/MATLAB
Lab Objectives:
1 To implement Generative and Probabilistic models and understand its working
2 To analyse the Architecture and Training process of Autoencoders.
3 To apply the concepts of transfer learning towards useful outcomes.
4 To demonstrate the application of ensemble learning.
5 To realise the penetration of Nascent AI technologies in real life applications.
Lab Outcomes: At the end of the course, the students will be able to
1 Implement Generative and Probabilistic models and understand its working.
2 Build and Train Autoencoders models.
3 Solving real life problems using transfer learning.
4 Design models based on ensemble learning approach.
5 Conceptualise the designs and advancement of AI technologies in real life applications.

Suggested 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 autoencoder 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

Useful Links	
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/

Term Work:	
1	Term work should consist of any 06 experiments, 1 case study, Mini Project.
2	Journal must include at least 2 assignments based on Theory and Practical's.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral exam	
	Oral examination on the entire syllabus of **CSC801 and CSL801**

Lab Code	Lab Name	Credit
CSDOL8011	**AI for financial & Banking application Lab**	**1**

Prerequisite: Python Programming, Deep Learning, Machine Learning.	
Lab Objectives: Students will try	
1	To implement digital money transfer systems in the banking sector.
2	To calculate risk-adjusted performance measures for investment portfolios.
3	To apply cluster analysis to identify patterns in financial data.
4	To analyze market sentiment using the Markov regime switching model.
5	To design and backtest trading algorithms for financial markets
6	To detect and prevent fraudulent activities using fraud analytics techniques
Lab Outcomes: At the end of the course, the students will be able to	
1	Proficiency in implementing secure and efficient digital money transfer systems.
2	Ability to assess investment performance using risk-adjusted measures.
3	Competence in identifying meaningful patterns and segments in financial data.
4	Understanding of market sentiment and its impact on trading decisions.
5	Practical skills in developing and evaluating trading algorithms.
6	Knowledge of fraud detection methods for financial systems.

Suggested List of Experiments	
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

Textbooks:	
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

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

Digital 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

Term Work:	
1	Term work should consist of 10 experiments and 2 assignments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments and Project: 15-marks, Attendance(Theory & Practical): 05-marks, Assignment: 05-marks)
Practical and Oral exam	
	Oral examination on the entire syllabus of **CSDO8011 & CSDOL8011**

Lab Code	Lab Name	Credit
CSDOL8012	**Quantum Computing Lab**	1

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

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

Sr. No.	Name of the Experiment
1	Building Quantum dice
2	Building Quantum Random No. Generation
3	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.

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

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam:	
Oral examination based on the entire syllabus of CSDO8012 and CSDOL8012	

Course Code:	Course Title	Credit
CSDOL8013	**Reinforcement Learning Lab**	**1**

Prerequisite: Python Programming, Deep Learning, Machine Learning.

Lab Objectives: Students will try

1	Introduce the fundamentals of reinforcement learning and problem formulation using MDPs and Bandit problems
2	Explode different exploration strategies and their impact on online leaning scenarios.
3	Understand dynamic programming algorithms for solving Markov Decision Processes.
4	Apply dynamic programming techniques to solve small-scale MDP problems
5	Implement and compare Monte Carlo methods and Temporal-Difference learning algorithms.
6	Explore real-world applications of reinforcement learning in domains such as autonomous driving or robotics

Lab Outcomes: At the end of the course, the students will be able to

1	Gain a solid understanding of reinforcement learning concepts and problem formulation.
2	Evaluate and compare exploration strategies in online learning scenarios.
3	Solve Markov Decision Processes using dynamic programming algorithms
4	Apply dynamic programming techniques to solve small-scale MDP problems.
5	Implement and analyze Monte Carlo methods and Temporal-Difference learning algorithms
6	Explore practical applications of reinforcement learning in real-world domains.

Suggested List of Experiments	
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.

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.

References 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. Csaba Szepesv´ari, Algorithms for Reinforcement Learning, Morgan & Claypool Publishers
3. Alberto Leon-Garcia, Probability, Statistics and Random Processes for Electrical Engineering, Third Edition, Pearson Education, Inc.

Useful Links
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

Term Work:	
1	Term work should consist of any 8 experiments, 1 case study and 2 assignments.
2	The final certification and acceptance of term work ensures satisfactory performance o

	laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments and Project: 15-marks, Attendance(Theory & Practical): 05-marks, Assignment: 05-marks)

Oral exam

Oral Examination based on the entire syllabus of **CSDO8013 and CSL8013**

Lab Code	Lab Name	Credit
CSDOL8021	**Graph Data ScienceLab**	**1**

Lab Objectives:	Students will try

	Lab Objectives: Students will try
1	To understand graph database fundamentals and their advantages.
2	To design and implement effective data models using the labeled property graph model.
3	To develop proficiency in querying and analyzing graph data using Cypher.
4	To gain knowledge of graph database administration tasks and data management.
5	To apply graph database techniques to real-world use cases.
6	To develop practical skills in graph database application development.
	Lab Outcomes: At the end of the course, the students will be able to
1	Comprehensive understanding of graph databases and their benefits.
2	Proficiency in creating data models for representing complex relationships.
3	Ability to write efficient queries and analyze graph data effectively.
4	Competence in administering and managing graph databases.
5	Application of graph database techniques to solve real-world problems.
6	Understand developing graph database applications.

Prerequisite: Python Programming, Deep Learning, Machine Learning.

Suggested List of Experiments

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.

Textbooks:	
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

References:	
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.
Digital References:	

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

Term Work:	
1	Term work should consist of any 8 experiments , 1 case study and 2 assignments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments and Project: 15-marks, Attendance(Theory & Practical): 05-marks, Assignment: 05-marks)
Oral exam	
	Oral examination on the entire syllabus of **CSDO8021 and CSDOL8021**

Course Code:	Course Title	Credit
CSDOL8022	Recommendation Systems Lab	1

Prerequisite: Java/Python
Lab Objectives:
1	To understand the key concepts of Recommendation systems.
2	Design and implement cluster-based approaches for recommendation systems.
3	Design, implement and analyze classification algorithms for recommendation systems.
4	To understand various Recommendation system Algorithms.
5	To understand data processing for Recommendation system Algorithms
Lab Outcomes: At the end of the course, the students will be able to
1	Understand mathematics and representation of data for recommendation systems.
2	Design, implement and analyze Collaborative filtering based for recommendation systems.
3	Design, implement and analyze Content-based recommendation systems.
4	Design, implement and analyze Knowledge-based recommendation systems.
5	Understanding feature engineering and pre-processing for recommendation systems.
6	To solve real world problems using recommendation systems.

Suggested 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

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

Term Work:	
1	Term work should consist of any 08 experiments and mini project
2	Journal must include at least 2 assignments based on Theory and Practical's
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral exam:	
	Oral examination based on the entire syllabus of **CSDO8022 and CSL8022**

Lab Code	Lab Name	Credit
CSDOL8023	**Social Media Analytics Lab**	**1**

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

Suggested Experiments:	
Sr. No.	**Name of the Experiment**
1	Study various - i) Social Media platforms (Facebook, twitter, YouTubeetc) ii) Social Media analytics tools (Facebook insights, google analytics net lyticetc) 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 visualizationof 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.

Reference Books:	
1	Python Social Media Analytics: Analyze and visualize data from Twitter, YouTube, GitHub, and more Kindle Edition by Siddhartha Chatterjee , Michal Krystyanczuk
2	Learning Social Media Analytics with R,byRaghav Bali, Dipanjan Sarkar, Tushar Sharma.
3	Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013
4	Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013
5	Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	**Total 25 Marks** (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Practical and Oral Exam	
Oral examination based on the entire syllabus of **CSDC8023** and **CSDL80223**	

Course Code:	Course Title	Credit
CSP801	**Major Project 2**	**6**

Course Objectives:	
1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.
Course Outcomes:	
1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group
3	Draw the proper inferences from available results through theoretical/ experimental/simulations
4	Analyse the impact of solutions in societal and environmental context for sustainable development.
5	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
6	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 maintainattendance 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:
o Abstract
o Introduction
o Literature Survey/ Existing system
o Limitation Existing system or research gap
o Problem Statement and Objective
o Proposed System
   o Analysis/Framework/ Algorithm
   o Design details
   o Methodology (your approach to solve the problem) Proposed System
o Experimental Set up

- o Details of Database or details about input to systems or selected data
- o Performance Evaluation Parameters (for Validation)
    - o Software and Hardware Setup
- o Results and Discussion
- o Conclusion and Future Work
- o References
- o Appendix – List of Publications or certificates

Desirable:
Students should be encouraged -
- o to participate in various project competition.
- o to write minimum one technical paper & publish in good journal.
- o to participate in national / international conference.

3. Term Work:

Distribution of marks for term work shall be done based on following:
- a. Weekly Log Report
- b. Completeness of the project and Project Work Contribution
- c. Project Report (Black Book) (both side print)
- d. Term End Presentation (Internal)

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

4. Oral & Practical:

Oral &Practical examination (Final Project Evaluation) of Project 2 should be conducted by Internal and External examiners approved by University of Mumbai at the end of the semester.

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