V. E. S. Institute of Technology

Department of Artificial Intelligence and Data Science

(Semester VII – to VIII)

Final Year

Autonomy Syllabus

Effective A.Y. 2024-25

Program Structure for Fourth Year AI&DS

Scheme for Autonomous Program

With Effect from (2024-2025)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract. Tut.**	**Theory**	**Pract.**	**Total**
ADC701	Deep Learning	3	--	3	--	3
ADC 702R	Big Data Analytics	3	--	3		3
ADDO 701X	Department Level Optional Course- 3	3	--	3	--	3
ADDO 702X	Department Level Optional Course- 4	3	--	3	--	3
ILO701X	Institute Level Optional Course- 1	3	--	3	--	3
ADL701	Deep Leaning Lab	--	2	--	1	1
ADL 702R	Big Data Analytics Lab	--	2	--	1	1
ADDOL 701X	Department Level Optional Course- 3 Lab	--	2	--	1	1
ADDOL 702X	Department Level OptionalCourse- 4 Lab	--	2	--	1	1
AD CP701	Major Project1	--	6#	--	3	3
Total		**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Prac.	Total
		Internal Assessment		End Sem Exam	Exam. Duration (in Hrs)			
		Mid Test	CA*					
ADC701	Deep Learning	20	20	60	2	--	--	100
ADC 702R	Big Data Analytics	20	20	60	2	--	--	100
ADDO 701X	Department Level Optional Course-3	20	20	60	2	--	--	100
ADDO 702X	Department Level Optional Course-4	20	20	60	2	--	--	100
ILO 701X	Institute Level Optional Course-1	20	20	60	2	--	--	100
ADL701	Deep Leaning Lab	--	--	--	--	25	25	50
ADL 702R	Big Data Analytics Lab	--	--	--	--	25	25	50
ADLDOL 701X	Department Level Optional Course-3 Lab					25	-	25
ADLDOL 702X	Department Level OptionalCourse-4 Lab	--	--	--	--	25	-	25
AD CP701	Major Project1	--	--	--	--	50	25	75
Total		**--**	**--**	**400**	**--**	**150**	**75**	**725**

Program Structure for Fourth Year AI&DS

(With Effect from 2024-2025)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ADC801	Advanced Artificial Intelligence	3	--	3	--	3
ADDO 801X	Department Level Optional Course- 5	3	--	3	--	3
ADDO 802X	Department Level OptionalCourse 6	3	--	3	--	3
ILO8 01X	Institute Level OptionalCourse-2	3	--	3	--	3
ADL801	Advanced Artificial Intelligence Lab	--	2	--	1	1
ADDOL 801X	Department Level Optional Course-5 Lab	--	2	--	1	1
ADDOL 802X	Department Level Optional Course-6 Lab	--	2	--	1	1
ADP801	Major Project-2	--	12#	--	6	6
Total		**12**	**18**	**12**	**9**	**21**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract.	Total
		Internal Assessment		End Sem Exam	Exam Duration (in Hrs)			
		Mid Test	CA*					
ADC801	Advanced Artificial Intelligence	20	20	60	2	--	--	100

ADDO 801X	Department Level Optional Course -5	20	20	60	2	--	--	100
ADDO 802X	Department Level Optional Course -6	20	20	60	2	--	--	100
ILO 801X	Institute Level Optional Course-2	20	20	60	2	--	--	100f
ADL801	Advanced Artificial Intelligence Lab	--	--	--	--	25	25	50
ADDOL 801X	Department Level Optional Course -5 Lab	--	--	--	--	25	25	50
ADDOL 802X	Department Level Optional Course -6 Lab					25	25	50
ADP801	Major Project 2	--	--	--	--	75	75	150
Total		**--**	**--**	**400**	--	**150**	**150**	**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

Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject and Labs
VII	Department Optional Course -3	ADDO7011: Natural Language Processing ADDO7012: AI for Healthcare ADDO7013: Neural Network & Fuzzy System
	Department Optional Lab -3	ADDOL7011: Natural Language Processing Lab ADDOL7012.: AI for Healthcare Lab ADDOL7013: Neural Network & Fuzzy System
	Department Optional Course -4	ADDO7021: User Experience Design with VR ADDO7022: Blockchain Technologies ADDO7023: Game Theory for Data Science
	Department Optional Lab -4	ADDOL7021: User Experience Design with VR Lab ADDOL7022: Blockchain Technologies ADDOL7023: Game Theory for Data Science
	Institute level Optional Courses- I	ILO7011:Product Lifecycle Management ILO7012: Reliability Engineering ILO7013.: Management Information System ILO7014: Design of Experiments ILO7015: Operation Research ILO7016: Cyber Security and Laws ILO7017: Disaster Management & Mitigation Measures ILO7018: Energy Audit and Management ILO7019: Development Engineering

Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject and Labs
VIII	Department Optional Course -5	ADDO8011: AI for financial & Banking application ADDO8012: Quantum Computing ADDO8013: Reinforcement Learning
	Department Optional Lab -5	ADDOL8011: AI for financial & Banking application Lab ADDOL8012: Quantum Computing Lab ADDOL8013: Reinforcement Learning Lab
	Department Optional Course -6	ADDO8021: Graph Data Science ADDO8022: Recommendation Systems ADDO8023: Social Media Analytics
	Department Optional Lab -6	ADDOL8021: Graph Data Science Lab ADDOL8022: Recommendation Systems Lab ADDOL8023: Social Media Analytics Lab
	Institute level Optional Courses-II	ILO8021: Project Management ILO8022: Finance Management ILO8023: Entrepreneurship Development and Management ILO8024: Human Resource

		Management ILO8025: Professional Ethics and CSR ILO8026: Research Methodology ILO8027: IPR and Patenting ILO8028: Digital Business Management ILO8029: Environmental Management

Course Code:	Course Title	Credit
ADC701	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	Hrs
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, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharin in CNN, Fully Connected NN vs CNN, Variants of basic Convolution functio 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	
		Total	**39**

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

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

End Semester Theory Examination:

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

Course Code	Course/Subject Name	Credits
ADC702R	**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,
3	To introduce to the students several types of big data like web graphs and data streams.
4	To introduce the concept of Generative AI and applications
5	To familiarize the students with concepts of Prompts, Large Language Models (LLMs) and ethics
Course Outcomes:	
1	Understand the key issues in big data management and its associated applications for business decisions and strategy.
2	Demonstrate an ability to use frameworks like Hadoop, NOSQL and paradigms like MapReduce to efficiently store retrieve and perform data Intensive activities for Big Data Analytics.
3	Design and implement algorithms to analyze Big data, like Data streams, Web Data.
4	Understand the architecture and functioning of Gen AI models

5	Demonstrate a deep understanding of LLMs and fine-tuning, enabling them to apply these skills in practical scenarios
6	Discuss ethical and societal implications of using Gen AI models.

Module		Content	Hrs.
0		**Prerequisites: Data Mining, Python, Deep Learning**	
1		**Introduction to Big Data**	3
	1.1	Introduction to Big Data, Big Data characteristics, Structured, Semi-Structured and Non-Structured Data. Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications- Brief introduction to Data Streams, Recommendation Systems, Social Networks, WWW.	
2		**Introduction to Big Data Frameworks: Hadoop, MapReduce**	8
	2.1	Need for a framework for Big Data Computing. Introduction to Hadoop. Core Hadoop Components; Hadoop Ecosystem; **What is NoSQL?** CAP Theorem, BASE characteristics for Databases; NoSQL 4 data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores. **Introduction to Map Reduce:** The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Partitioners, **Algorithms Using MapReduce:**· Matrix-Vector Multiplication, Relational-Algebra Operations - Computing Selections, Projections, Union, Intersection, and Difference , Database operations - Computing Natural Join, Group By and Aggregation, Matrix Multiplication with two and One MapReduce Steps. **Illustrating benefits of MapReduce:** Real life examples of databases and applications	
3		**Mining Big data stream link analysis**	8
	3.1	**The Stream Data Model:** A Data stream management system, Examples of Stream Sources,Stream Queries, Issues in Stream processing , sampling data in a stream : sampling techniques. Filter streams: The bloom filter **Counting Distinct Elements in a Stream** : The Count-Distinct Problem, The Flajolet-Martin Algorithm, **Counting Ones in a Window:** The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm. **Link Analysis :** Early Search Engines, Spam PageRank Definition, Structure of the web, dead ends, Spider traps, Using Page rank in a search engine, Efficient computation of Page Rank using matrices. link Spam and spam Farm, HITS Algorithm.	

4		**Introduction to Generative AI**	**6**
	4.1	Overview of General AI and its significance; Historical context and evolution of AI models. Introduction to Gen AI models like ChatGPT, Gemini, CoPilot. Key concepts and terminology; Architecture and Capabilities. Training processes and data requirements Comparison with other AI models Demonstration of capabilities through examples	
5		**Large Language Models**	**8**
	5.1	Understanding LLMs: Architecture and Components Training LLMs: Data, computation, and algorithms Practical applications of LLMs Introduction to fine-tuning pre-trained models- Transfer Learning and Fine-Tuning: Overview of fine tuning techniques – Supervised, PEFT. Introduction Retrieval Augmented Generations	
6		**Prompt Engineering Applications And Ethical Considerations**	**6**
	6.1	Basics of prompt engineering Designing effective prompts for different tasks Prompting Techniques- Zero Shot, One-shot, Few Shot, Chain of thought. Ethical considerations in Gen AI deployment- Bias and fairness, Privacy concerns and data security Use cases in healthcare, finance, customer service, and other domains.	
		Total	**39**

Textbooks:	
1	Radha Shankarmani, M Vijayalakshmi, ”Big Data Analytics”, Wiley Publications,
2	Anand Rajaraman and Jeff Ullman “Mining of Massive Datasets”, Cambridge University Press.
3	Alex Holmes “Hadoop in Practice”, Manning Press, Dreamtech Press.
4	Professional NoSQL Paperback, by Shashank Tiwari, Dreamtech Press

5	Generative AI with LangChain, by Ben Auffarth, Released December 2023, Publisher(s): Packt Publishing,ISBN: 9781835083468
6	Quick Start Guide to Large Language Models Strategies and Best Practices for using ChatGPT and Other LLMs Sinan Ozdemir Addison-Wesley
References:	
1	Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big Data Series.
2	Big Data Analytics with R and Hadoop by Vignesh Prajapati Paperback, Packt Publishing Limited
3	Hadoop: The Definitive Guide by Tom White, O'Reilly Publications
4	Prompt Engineering for Generative AI: Future-Proof Inputs for Reliable AI Outputs (Grayscale Indian Edition) Paperback – 29 May 2024 by James Phoenix (Author), Mike Taylor (Author)
5	Artificial Intelligence & Generative AI for Beginners by David M. Patel 5 Book series

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment: - Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

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

Course Code:	Course Title	Credit
ADDO7011	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, MorphologicalAnalysis, 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.	
		Total	**39**

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

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

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

Course Code	Course/Subject Name	Credits
ADDO7012	AI for Healthcare	3

Prerequisites: Artificial Intelligence, Machine Learning	
Course Objectives:	
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		Content	Hrs.
1		**Introduction**	**6**
	1.1	Overview of AI , ML and DL ,A Multifaceted Discipline, Applications of AI in Healthcare - Prediction, Diagnosis, personalized treatment and behavior modification, drug discovery, followup care etc,	

	1.2	Realizing potential of AI in healthcare, Healthcare Data - Use Cases.	
2		**AI, ML, Deep Learning and Data Mining Methods for Healthcare**	**8**
	2.1	Knowledge discovery and Data Mining, ML, Multi classifier Decision Fusion, Ensemble Learning, Meta-Learning and other Abstract Methods.	
	2.2	Evolutionary Algorithms, Illustrative Medical Application-Multiagent Infectious Disease Propagation and Outbreak Prediction, Automated Amblyopia Screening System etc.	
	2.3	Computational Intelligence Techniques, Deep Learning, Unsupervised learning, dimensionality reduction algorithms.	
3		**Evaluating learning for Intelligence**	**4**
	3.1	Model development and workflow, evaluation metrics, Parameters and Hyperparameters, Hyperparameter tuning algorithms, multivariate testing, Ethics of Intelligence.	

4		**Natural Language Processing in Healthcare**	**8**
	4.1	NLP tasks in Medicine, Low-level NLP components, High level NLP components, NLP Methods.	
	4.2	Clinical NLP resources and Tools, NLP Applications in Healthcare. Model Interpretability using Explainable AI for NLP applications.	
5		**Intelligent personal Health Record**	**5**
	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.	
		Total	**39**

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

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

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

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

Course Code:	Course Title	Credit
ADDO7013	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		**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 ,Fuzzy relations composition, Tolerance and Equivalence Relationship.	
	1.3	**Membership Functions:** Features of Membership Functions, Fuzzification, Methods of membership value assignments.	
2		**Fuzzy Rules, Reasoning, and Inference System**	**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		**Associative Memory Networks**	**6**
	3.1	**Introduction:** Basics of associative memory networks, Training algorithms for Pattern Association.	
	3.2	**Types of Networks:** Radial basis function network : architecture training algorithm**,** Auto-associative Memory Network – Architecture, Flowchart of training process, Training algorithm, Testing algorithm, Hetero- associative Memory Network- Architecture and Testing algorithm, Bidirectional Associative Memory(BAM) Network- Architecture, Discrete BAM, Continuous BAM.	
4		**Unsupervised Learning Networks**	**8**
	4.1	**Introduction :** Fixed weight competitive nets**,** Maxnet, Maxican net, Hamming Network	

	4.2	**Kohonen Self- Organizing Feature Maps:** Basic concepts, Architecture, Flowchart, Algorithms, Kohonen, Self-Organizing Motor map, Training algorithm.	
	4.3	**Adaptive resonance Theory:** Architecture, Fundamental Operating principles, a Algorithms, Adaptive Resonance Theory I – Architecture, Flowchart of Training process, Training algorithm, Adaptive Resonance Theory 2 - Architecture, Algorithm, Flowchart, Training algorithm, Sample Values of Parameter.	
5		**Special Network**	**5**
	5.1	**Introduction:** Boltzmann Machine, Gaussian Machine, Probabilistic neural nets Spatio-Temporal connection network model, Ensemble neural model Extreme learning machine models, Online, Pruned, Improved Application of ELM	

6		**Hybrid Computing**	**5**
	6.1	**Neuro-Fuzzy Hybrid Systems:** Introduction to Neuro-Fuzzy systems, Comparison of Fuzzy systems and Neural networks, Characteristics of Neuro-Fuzzy systems, Classification of Neuro-Fuzzy systems. Introduction to Adaptive Neuro-Fuzzy Inference System (ANIFS), ANFS Architecture, Constraints of ANFIS, ANFIS as a Universal Approximator.	
		Total	**39**

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:	
1	https://onlinecourses.nptel.ac.in/noc22_ee21/preview
2	https://onlinecourses.nptel.ac.in/noc23_ge15/preview

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

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

Course Code:	Course Title	Credit
ADDO7021	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**	**4**
	1.1	Introduction to interface design, Understanding and conceptualizing Interface, understanding user's conceptual cognition, Core Elements of User Experience, Working of UX elements	

2		**The UX Design - life cycle**	**7**
	2.1	What is UX, Ubiquitous interaction, Emerging desire for usability, From usability to user experience, Emotional impact as part of the user experience, User experience needs a business case, Roots of usability.	
	2.2	Introduction, A UX process lifecycle template, Choosing a process instance for your project, The system complexity space, Meet the user interface team, Scope of UX presence within the team, More about UX lifecycles.	

3		**The UX Design Process**	**10**
	3.1	Introduction, The system concept statement, User work activity gathering, Look for emotional aspects of work practice, Abridged contextual inquiry process, Data-driven vs. model driven inquiry, Contextual Analysis, Extracting Interaction Design Requirements, Constructing Design Information Models.	
	3.2	Information ,Architecture and Interaction Design and Prototyping Introduction, Design paradigms, Design thinking, Design perspectives, User personas, Ideation, Sketching, More about phenomenology, Mental Models and Conceptual Design, Wireframe, Prototyping	
4		**The UX Design Process**	**6**
	4.1	UX Evaluation and Improve UX Goals, Metrics and Targets, UX Evaluation Techniques.- Formative vs summative ,types of formative and informal summative evaluation methods, types of evaluation data, some data collection techniques	
	4.2	Rapid Evaluation Methods: Design walkthroughs and reviews UX Inspection, Heuristic evaluation, a UX inspection method, practical approach to UX Inspection, Do UX Evaluation rite, Quasi-empirical UX evaluation Questionnaires, Specialized rapid UX evaluation methods	
5		**Introduction to Virtual Reality**	**6**
	5.1	Defining Virtual Reality, The three I's of Virtual Reality, History, The five classic components of a VR system, Input Devices: Trackers, Navigation and Gesture Interfaces,	
	5.2	Output Devices: Graphics, Three dimensional sound and Haptic displays	
6		**Virtual Reality**	**6**

	6.1	Modeling: Geometric modeling, Kinematics modeling, Physical Modeling, Behaviour modeling, Model management. Human factor in VR: Methodology and terminology, User performance studies. Traditional VR Applications, Emerging Applications of VR.	
		Total	**39**

Textbooks:	
1	The UX Book Process and Guidelines for Ensuring a Quality User Experience by Rex Hartson, Pardha payla
2	Interaction Design, Beyond Human Computer Interaction, Rogers, Sharp, Preece Wiley India Pvt Ltd.
3	The UX Book by Rex Hartson and PardhaPyla, MK Publication
4	Smashing UX Design by Jesmond Allen and James Chudley, John Wiley & Sons

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

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

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

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

Course Code:	Course Title	Credit
ADDO7022	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.	
		Total	**39**

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

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:

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

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

Course Code:	Course Title	Credit
ADDO7023	Game Theory for Data Science	3

Prerequisite: Probability Algebra	
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 are appropriate, including electronic trading markets.
2.	To formalize the notion of strategic thinking and rational choice by using the tools of 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, computer science, and economics.
5.	To apply game theory in searching, auctioning and trading.

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 aspects and 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 typical Virtual 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

Sr. No.	Module	Content	Hrs.
		Prerequisite	
0	**0.1**	Probability , Algebra	**1**
1		**Introduction**	
	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).	**6**
2		**Games with Perfect Information**	
	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.	**7**
3		**Games with Imperfect Information**	
	3.1	Games with Imperfect Information – Bayesian Games – Motivational Examples – General Definitions – Information aspects – Illustrations – Extensive Games with Imperfect – Information – Strategies – Nash Equilibrium – Beliefs and sequential equilibrium – Illustrations – Repeated Games – The Prisoner's Dilemma – Bargaining.	**6**
4		**Non-Cooperative Game Theory**	
	4.1	Non-cooperative Game Theory – Self-interested agents – Games in normal form – Analyzing games: from optimality to equilibrium – Computing Solution Concepts of Normal – Form Games – Computing Nash equilibria of two-player, zero-sum games –Computing Nash equilibria of two-player, generalsum games – Identifying dominated strategies	**7**
5		**Mechanism Design Aggregating Preferences**	

	5.1	Social Choice – Formal Model – Voting – Existence of social functions – Ranking systems – Protocols for Strategic Agents: Mechanism Design – Mechanism design with unrestricted preferences – Efficient mechanisms – Vickrey and VCG mechanisms (shortest paths) – Combinatorial auctions – profit maximization Computational applications of mechanism design – applications in Computer Science – Google's sponsored search – eBay auctions – K-armed bandits.	**6**

6		**Repeated Games**	
	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	**6**
		Total	**39**

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

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

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

Lab Code	Lab Name	Credit
ADL701	**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:	
Sr. No.	**Name of the Experiment**
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.
5	**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(min) to 12(max) experiments.
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 for Experiments
Evaluation Exam	
1	Practical based on the subject and related lab of Deep Learning and Theory

Course Code	Course Name	Credits
ADL702R	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 familiarize the students with concepts of Prompts, Large Language Models (LLMs)
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	Design and test big data algorithms like BLOOM filter,FM and DGIM
5	Implement page rank and hits algorithm using map reduce.
6	Analyze deep understanding for LLMs and pply these skills in practical scenarios

Suggested List of Experiments:	
Sr. No.	**Name of the Experiment**
1	Assignment on Study of Hadoop ecosystem
2	Programming exercises on Hadoop Using Hive, Pig, Hbase Sqoop NOSQL.
3	Implementing simple algorithms in Map- Reduce Matrix multiplication, Aggregates, joins, sorting, searching etc.
4	Big Data Applications (any 2) ● Blooms Filter ● FM algorithm for counting distinct elements ● DGIM algorithm for counting number of ones
5	Implementing either Page Rank or HITS algorithm using Map Reduce
6	Implement Nosql : MongoDB
7	Implementation of Langchain API 1. prompt template 2. LLM chain 3. Prompt template with multiple variables 4. Conversation Chain
8	Using streamlit call Gemini API to read a image.

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 8(min) to 12(max) experiments.
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 for Experiments
Evaluation Exam	
1	Practical exam based on the subject and related lab of Big data analytics lab and theory

Course Code:	Course Title	Credit
ADDOL7011	**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 List of 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 8(min) to 12(max) experiments.
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 for Experiments

Course Code:	Course Title	Credit
ADDOL7012	AI for Healthcare Lab	1

Prerequisites: Python	
Lab Objectives:	
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(min) to 12(max) experiments.

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 for experiments

Course Code:	Course Title	Credit
ADDL7013	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 8(min) to 12(max) experiments.
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 for Experiments

Course Code:	Course Title	Credit
ADDOL7021	User Experience Design with VR Lab	1

Prerequisite: Computer Graphics, Python	
Lab Objectives:	
1	Analyze how to design Effective and Efficient User Interfaces for intended users
2	Learn techniques for Prototyping and Evaluating User Experience
3	Apply the concept of Good UI and User Experience (UX)
4	To perform installation of Unity and explore working of VR Gadget
5	To develop scene VR application
Lab Outcomes:	
1	Demonstrate the tools and techniques for designing informing models
2	Develop a high fidelity prototype for an end end solution.
3	Apply best practices for evaluating user experience.
4	Setup VR development environment and use HTC Vive/ Google Cardboard/ Google Daydream and Samsung gear VR.
5	Develop VR scene and place object

Suggested Experiments:	
Sr. No.	**Name of the Experiment**

1	Project Proposal and Requirement Gathering (Choose the project). Briefly state the problem(s) that the project will seek to solve. Take the user's point of view. Consider what the user's goals are, and what obstacles lie in the way.
2	Creation of Scenario : Write a scenario that involves all three of the tasks identified for the chosen project.
3	Creating a Paper Prototype on selected problem statement.
4	High Fidelity prototype (Wire Frame) using Figma tool.
5	Usability Evaluation of the Design Testing of User Interface from Third Party(Test scripts)
6	Design an interactive design for the selected problem.

7	Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
8	Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
9	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
10	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 .

Useful Links

1	https://www.coursera.org/professional-certificates/google-ux-design
2	https://nptel.ac.in/courses/124107008
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 8(min) to 12(max) experiments.
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 for Experiments

Course Code:	Course Title	Credit
ADDOL7022	Blockchain 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.

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 8(min) to 12(max) experiments.
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 for Experiments

Mini project:

Students should carry out mini-project in a group of three/four students with a subject In-charge

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

Course Code:	Course Title	Credit
ADDOL7023	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 List of Experiments:	
Sr. No.	**Name of the 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 8(min) to 12(max) experiments.
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 for Experiments

Course Code:	Course Title	Credit
ADP701	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
  - 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 that will be useful and applicable for projects.)

3. Term Work:

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

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

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

4. Oral and Practical:

Oral and Practical examination (Final Project Evaluation) of Project 1 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 follows:

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

Course Code	Course Title	Credit
ADC801	**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		**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		**Generative Adversarial Network**	**07**
	2.1	**Basics of GAN :** Generative Adversarial Networks (GANs) architecture, The discriminator model and generator model, Architecture and Training GANs, Vanilla GAN Architecture. GAN variants and improvements (DCGAN, WGAN, Conditional GAN, CycleGAN), Challenges- Training instability and model collapse, GAN applications in image synthesis and style transfer.	

3		**Variational Autoencoders**	**07**
	3.1 **3.2**	**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. **Types of Autoencoders:** Undercomplete autoencoders, Sparse autoencoders, Contractive autoencoders, Denoising autoencoders, Variational Autoencoders (for generative modelling)	
4		**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		**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		**Nascent Technologies in AI**	**06**
	6.1	**Convergence of AI with Augmented / virtual reality techniques for product and process development** Limitations of 2D Learning Environments, Evolution of virtual worlds and immersive technologies, Definition and concepts of Augmented Reality, Definition and concept of the Metaverse, Characteristics and components of the Metaverse, Challenges and opportunities in the Metaverse ecosystem, AI in the realm of emerging quantum computing	
		Total	**39**

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:	
1	https://nptel.ac.in/courses/106106201
2	https://onlinecourses.nptel.ac.in/noc20_cs62/preview
3	https://machinelearningmastery.com/what-are-generative-adversarial-networks-gans/

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:-

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions

3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Course Code	Course Name	Total
ADDO8011	AI for financial & Banking application	03

Course Objectives	
1	To understand the impact of technology and digitization on financial and banking enterprises.
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.	Content	Hrs.

1	**Information Technology Infrastructureand Digitization of Financial Banking Enterprises** Digital Technology driven processes, Blockchain technologies for Financial – Banking sector, GIFT cities Digital Money transfer Mechanisms. Digitization/ cloud services and solutions in banking and financial services Profiling enterprise software's in financial and banking enterprises.Building Efficiencies, productivity, and infallibility in financial & Banking operations. Detailed study of various processes which shall be transformed by AI integration in banking and financial services. Self-learning : Introduction to business efficiencies, industrial productivity and high degree reliability systems for competitive advantage and carbon neutral enterprises.	**04**

2	**Financial Statistics and The Sharpe Ratio** Probability, Combinatorics, Mathematical Expectation ,Sample Mean, Standard Deviation, and Variance ,Sample Skewness and Kurtosis ,Sample Covariance and Correlation ,Financial Returns ,Capital Asset Pricing Model ,Sharpe Ratio Formula, Time Periods and Annualizing, Ranking Investment Candidates, The Quantmod Package, Measuring Income Statement Growth, Sharpe Ratios for Income Statement Growth	**07**
3	**Cluster Analysis** 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	**07**
4	**Gauging the Market Sentiment** 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	**07**
5	**Trading algorithms** 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	**07**
6	**Fraud Analytics** 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	**07**
	Total	**39**

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

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks

6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

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

Course Code	Course Title	Credit
ADDO8012	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	Ion Trap Qubits ,The DiVincenzo Criteria , Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating	
	5.2	Rotor Quantum Mechanics of a Free Rotor: A Poor Person‘s Atomic	
	5.3	Model: Rotor Dynamics and the Hadamard Gate, Two-Qubit Gates The Cirac-Zoller Mechanism: Quantum Theory of Simple Harmonic Motion, A Phonon-Qubit Pair Hamiltonian, Light-Induced Rotor-Phonon Interactions, Trapped Ion Qubits, Mølmer-Sørenson Coupling ..	
	5.4	Cavity Quantum Electrodynamics (cQED): Eigenstates of the Jaynes-Cummings Hamiltonian Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms, Superconducting Qubits Quantum computing with spins: Quantum inverter realized with two exchange coupled spins 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)	
		Total	**39**

Textbooks:

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

References:	
1	Bernard Zygelman, A First Introduction to Quantum Computing and Information,2018
2	Supriyo Bandopadhyay and Marc Cahy, ―Introduction to Spintronics‖, CRC Press, 2008
3	The Second Quantum Revolution: From Entanglement to Quantum Computing and Other Super-Technologies, Lars Jaeger
4	La Guardia, Giuliano Gladioli ―Quantum Error correction codes‖Springer,2021
Digital References:	
1	https://onlinecourses.nptel.ac.in/noc21_cs103/preview
2	https://www.coursera.org/courses?query=quantum%20computing
3	https://www.cl.cam.ac.uk/teaching/1617/QuantComp/

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:-

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks

6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

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

Course Code:	Course Title	Credit
ADDO8013	Reinforcement Learning	3

Module	Content	Hours
0	**Prerequisite**	02
	Probability distributions and expected values, and basic linear algebra (e.g., inner products).	
1	**Introduction to Reinforcement Learning:**	04
	Reinforcement Learning: Key features and Elements of RL, Types of RL, rewards. Reinforcement Learning Algorithms: Q-Learning, State Action Reward State action (SARSA),	
2	Bandit problems and online learning:	07
	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:	07
	The Agent–Environment Interface, The Agent–Environment Interface, Goals and Rewards, Returns, Markov properties, Markov Decision Process, Value Functions and Optimal Value Functions,	
4	Dynamic Programming:	07
	Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration	
5	Monte Carlo Methods and Temporal-Difference Learning	07
	Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, TD Prediction, TD control using Q-Learning	
6	Applications and Case Studies	05

	Elevator Dispatching, Dynamic Channel Allocation, Job-Shop Scheduling	
	Total	**39**

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.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:-

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment/Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

End Semester Theory Examination:

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

Course Code	Course Name	Credit
ADDO8021	Graph Data Science	03

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.

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

Module	Content	Hours
1	**Introduction to Graph**	04
	Definitions and examples, Three puzzles, Paths and cycles, Connectivity, Eulerian graphs, Hamiltonian graphs, shortest path, Chinese postman problem, traveling salesman problem, trees, properties of trees	
2	**Introduction Graph databases**	07

	A High-Level View of the Graph Space, Graph Databases, Graph Compute Engines, The Power of Graph Databases, Performance, Flexibility, Agility, Options for Storing Connected Data, Relational Databases Lack Relationships, NOSQL Databases Also Lack Relationships, Graph databases embraces relationship	
3	**Data Modelling with Graphs**	**07**
	Models and Goals, The Labelled Property Graph Mode Querying Graphs, A Comparison of Relational and Graph Modelling, Cross-Domain Models, Common Modelling Pitfalls, Identifying Nodes and Relationships, Avoiding Anti-Patterns	
4	**Building a Graph Database Application**	**07**
	Data Modelling, Application Architecture, Testing , Capacity Planning, Importing and Bulk Loading Data,	
5	**Graphs in the Real-World**	**07**
	Organizations Choose Graph Databases, Common Use Cases, Real-World Examples, Authorization and Access Control, Geospatial and Logistics, Graph Database Internals, Native Graph Processing, Native Graph Storage Programmatic APIs, Kernel API, Core API, Traversa Framework, Non-functional Characteristics	
6	**Case Study**	**07**
	Neo4j – About, Neo4j – Installation, Neo4j – Browser Neo4j - Query Language (Cypher), Neo4j - Create a Node Neo4j - Create Relationship, Neo4j - Create an Index Neo4j - Create a Constraint, Neo4j - Select Data with MATCH, Neo4j - Import Data from CSV, Neo4j - Drop an Index, Neo4j - Drop a Constraint, Neo4j - Delete a Node, Neo4j - Delete a Relationship	
	Total	**39**

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/

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks

3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

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

Course Code:	Course Title	Credit
ADDO8022	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-Centered metrics. Comparative analysis between different types of recommendation systems.	
		Total	**39**

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.

Useful Links:	
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/

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
1	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Content beyond syllabus presentation	10 marks
3	Creating Proof of concept	10 marks
4	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5	Multiple Choice Questions (Quiz)	5 marks
6	GATE Based Assignment/Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

End Semester Theory Examination:

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

Course Code	Course Name	Credit
ADDO8023R	**Social Media Analytics**	**03**

Prerequisite: Graph Theory, Data Mining, Python/R programming	
Course Objectives: The course aims:	
1	To introduce and familiarize learners with the basics of social networks (nodes, edges, graphs, paths).
2	To Introduce various fundamental measures in social networks (centrality, density, clustering).
3	To Explore various community detection and network clustering techniques.
4	To Familiarize the learners with concepts of link analysis and prediction.
5	Familiarize the learner with advanced social network topics lie Cascades and information diffusion
6	To introduce the concept of Social media analytics and its various applications across popular social media
Course Outcomes:At the end of the course students will be able to	
1	Understand the concept of Social networks and how to represent them
2	Analyze and interpret social networks using different Social network measures.
3	Detect and analyze communities in Social networks.
4	Implement and design algorithms for Link analysis and link prediction in Social networks
5	Analyze information cascades and diffusion processes in Social networks.
6	Interpret the social media landscape and implement projects for real life social media applications

Module	Detailed Content	Hrs.
1.	**Social Media Analytics: An Overview**	

	Overview and Basic Concepts,Definition and importance of Social Networks and Social Network Analysis.(SNA) Historical background and evolution of SNA. Three Levels of SNA, Applications and tools. Preliminaries and Basic concepts: nodes, edges, graphs, networks. Graph Visualization Tools	6
2.	**Network Measures**	
	Degree and degree Distributions, Paths, Clustering Coefficient, Connected Components **Node Centrality** – Degree centrality, Closeness Centrality, Betweenness centrality, Edge Betweenness centrality, Assortativity, Transitivity and Reciprocity, Similarity. Properties of Real-World Networks – High Average Local Clustering Coefficient, Small-world Property, Scale-free Property. **Random Network Model**- Degree Distribution of Random Network, Evolution of a Random Network, Average Path Length, Clustering Coefficient,	8

3.	**Community Structure in Networks**	**7**
	Definition of Communities in social networks, Applications of Community Detection, Types of Communities. **Community Detection Methods:** Disjoint Community Detection- Node-Centric Community Detection, Modularity and Community Detection- Louvain Algorithm, Girvan Newman; Overlapping Community Detection: Clique Percolation, Link Partition Local Community Detection	
4.	**Link Analysis**	**6**
	Applications of Link Analysis, **Signed Networks** - Balance Theory of Undirected Signed Networks, Status Theory of Signed Networks, Triad Balance vs Status, **Strong and Weak Ties -** Strength of a Ties, Triadic Closure, Dunbar Number, Local Bridges and Importance of Weak Ties. **Link Prediction-** Applications of Link Prediction, Temporal Changes in a Network, Heuristic Models, Probabilistic Models, Latest Trends in Link Prediction	
5.	**Cascade Behaviour and Information Diffusion**	**4**

	Preliminaries and Important Terminologies, **Cascade Models** - Decision Based Models, Multiple Choice Decision-based Model; **Epidemic Models** - SEIR Model, SIR Model, SIS Model, Analysing Rumor Spread Spread - SEIZ Model; **Independent Cascade** Models - Cascade Prediction – DeepCas, DeepHawkes	
6.	**Social Media Analytics and Applications**	**8**
	Introduction to popular social media platforms, (Facebook, X, Instagram, LinkedIn etc) Key characteristics of social media data, (unstructured, large-scale, user-generated) Differences between traditional data and social media data. Tools for Social media Analytics Applications of Social media Analytics with Case studies - Mining X, FaceBook, Instagram, LinkedIn	
	Total	**39**

Textbooks:	
1.	Social Network Analysis, Tanmoy Chakraborty, Wiley Publications 2021
2.	Mining the Social Web, 3rd Edition, by Matthew A. Russell, Mikhail Klassen
3.	Analyzing the Social Web 1st Edition by Jennifer Golbeck
4	Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011
References:	
1.	P.M., Krishna & Mohan, Ankith & Srinivasa, K..Practical Social Network Analysis with Python. Springer
2.	Mining the Social Web, 3rd Edition, by Matthew A. Russell, Mikhail Klassen
3.	Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, Avinash Kohirkar, IBM Press
4.	Python Social Media Analytics: Analyze and visualize data from Twitter, YouTube, GitHub, and more Kindle Edition by Siddhartha Chatterjee , Michal Krystyanczuk

5.	Learning Social Media Analytics with R, byRaghav Bali, Dipanjan Sarkar, Tushar Sharma.

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/
5	https://www.cs.cornell.edu/home/kleinber/networks-book
6	https://networksciencebook.com/ - Albert-László Barabási

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:-

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr.no	Rubrics	Marks
	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
1.	Content beyond syllabus presentation	10 marks
2.	Creating Proof of concept	10 marks
3.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
4.	Multiple Choice Questions (Quiz)	5 marks
5.	GATE Based Assignment/Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

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

Course Code:	Course Title	Credit
ADL801	Advanced AI Lab	01

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	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 8(min) to 12(max) experiments.
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 for Experiments
Evaluation Exam	
Based on the subject and related lab of Adv AI and Theory	

Lab Code	Lab Name	Credit
ADDOL8011	**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 back test 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 Experiments:

Sr. No.	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 8(min) to 12(max) experiments.
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 for Experiments
Evaluation Exam	
Based on the subject and related lab of AI for financial & banking application Lab and theory	

Lab Code	Lab Name	Credit
ADDOL8012	**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 8(min) to 12(max) experiments.
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 for Experiments
Evaluation Exam	
Based on the subject and related lab of Quantum Computing and theory	

Course Code:	Course Title	Credit
ADDOL8013	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.

Sr. No.	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.

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 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 8(min) to 12(max) experiments.
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 for Experiments
Evaluation Exam	
Based on the subject and related lab of **Reinforcement Learning and theory**	

Lab Code	Lab Name	Credit
ADDOL8021	**Graph Data Science Lab**	**1**

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.

Sr. No.	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.
Useful Links:	
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 8(min) to 12(max) experiments.
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 for Experiments
Evaluation Exam	
Based on the subject and related lab of Graph Data Science and Theory	

Course Code:	Course Title	Credit
ADDOL8022	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 8(min) to 12(max) experiments.
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 for Experiments
Evaluation Exam	
Based on the subject and related lab of **Recommendation Systems and Theory**	

Lab Code	Lab Name	Credit
ADDOL8023 R	**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: Python or any social media analytics tool can be used	
Sr No.	**Name of the Experiment**
0	Study assignment of various popular social media like Facebook Instagram etc

1	Basic Network Construction and Visualization ● Objective: Learn how to create and visualize a simple social network graph. ● Tools: Python (NetworkX, Matplotlib). ● Task: Construct a small undirected or directed network using nodes and edges. Visualize the network with different layout algorithms (e.g., circular, spring, random). ● Key Metrics: Degree distribution, node labels, edge weights.
2	Centrality Measures on a Social Network ● Objective: Calculate and interpret different centrality measures. ● Tools: NetworkX, Pandas, Matplotlib. ● Task: Compute degree centrality, betweenness centrality, closeness centrality, and eigenvector centrality for a given social network (e.g., a dataset from Facebook or Twitter). ● Key Metrics: Identify important nodes based on centrality
3	Community Detection in Social Networks ● Objective: Detect communities using various algorithms. ● Tools: NetworkX, Python- Matplotlib. ● Task: Apply the Louvain algorithm, Girvan-Newman algorithm, Clique Percolation Method to detect communities in a social network (e.g., Zachary's Karate Club). ● Key Metrics: Modularity score, size of each community, and visual representation of the community structure.
4	Cascades and Information Diffusion Objective: Simulate Cascades and analyze information diffusion across a network. ● Tools: NetworkX, Pandas, Matplotlib. ● Task: Implement any information diffusion model (e.g., Independent Cascade Model or Linear Threshold Model). Simulate how information spreads across a social network and identify the key influencers and patterns of diffusion. ● Key Metrics: Diffusion depth, time to full diffusion, cascade size, and visualization of the diffusion process.
5	Dynamic Network Analysis and Temporal Visualization ● Objective: Analyze how a social network evolves over time. ● Tools: NetworkX, Matplotlib, Seaborn. ● Task: Analyze a temporal dataset (e.g., a series of email exchanges) to track how nodes and edges evolve. Visualize the network at different

	time slices. Key Metrics: Node/edge birth and death rates, visual progression of the network.
6	Link Prediction Algorithms ● Objective: Predict future connections between nodes in a social network. ● Tools: NetworkX, Scikit-learn, Pandas, Matplotlib. ● Task: Implement any link prediction algorithm to predict future links. Key Metrics: accuracy of the prediction model.
7	Analyzing Real-World Social Media Networks - Use tools to analyze popular social networks. The following list is a suggested list of experiments that can be done. 2 or 3 experiments can be done 1. Sentiment Analysis on Social Media Network 2. Extract and analyze social media networks using Twitter or Instagram API 3. Extract and Analyze Facebook Social Circles 4. Twitter Hashtag Co-occurrence Network 5. GitHub Collaboration Network 6. Instagram Influencer Network 7. Topic Propagation on Twitter 8. GitHub Fork Network Analysis 9. Instagram Hashtag Co-occurrence Network 10. Twitter User Interaction Network 11. Facebook Group Interaction Analysis

	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, 3rd Edition, O'Reilly Media
5	Social Network Analysis, Tanmoy Chakraborty, Wiley Publications 2021
6	P.M., Krishna & Mohan, Ankith & Srinivasa, K..Practical Social Network Analysis with Python. Springer

Term Work:	
1	Term work should consist of 8(min) to 12(max) experiments.
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 for Experiments
Evaluation Exam	
Based on the subject and related lab of Social Media Analytics and Theory	

Course Code:	Course Title	Credit
ADP801	**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:

- Abstract
- Introduction
- Literature Survey/ Existing system
- Limitation Existing system or research gap
- Problem Statement and Objective
- Proposed System
  - Analysis/Framework/ Algorithm
  - Design details
  - Methodology (your approach to solve the problem) Proposed System
- Experimental Set up
  - Details of Database or details about input to systems or selected data
  - Performance Evaluation Parameters (for Validation)
  - Software and Hardware Setup
- Results and Discussion
- Conclusion and Future Work
- References
- Appendix – List of Publications or certificates

Desirable:
Students should be encouraged -

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

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