



No. AAMS_UGS/ICC/2024-25/ 87

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions and the Head, University Departments is invited to this office circular No. AAMS_UGS/ICC/2023-24/23 dated 08th September, 2023 relating to the NEP UG & PG Syllabus.

They are hereby informed that the recommendations made by the **Ad-hoc Board of Studies in Information Technology** at its meeting held on 03rd June, 2024 and subsequently passed by the Board of Deans at its meeting held on 27th June, 2024 **vide** item No. 6.3 (N) have been accepted by the Academic Council at its meeting held on 28th June, 2024 **vide** item No.6.3 (N) and that in accordance therewith the **syllabus** for the **M.Sc. (I.T-Artificial Intelligence) (Sem. III & IV)** is introduced as per appendix (NEP 2020) with effect from the academic year 2024-25.

(The circular is available on the University's website www.mu.ac.in).

(Prof.(Dr) Baliram Gaikwad)
I/c Registrar

MUMBAI – 400 032
20th August, 2024

To

The Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Department.

A.C/6.3(N)/28/06/2024

Copy forwarded with Compliments for information to:-

- 1) The Chairman, Board of Deans,
- 2) The Dean, Faculty of Science & Technology,
- 3) The Chairman, **Ad-hoc Board of Studies in Information Technology**.
- 4) The Director, Board of Examinations and Evaluation,
- 5) The Director, Board of Students Development,
- 6) The Director, Department of Information & Communication Technology.
- 7) The Director, Institute of Distance and Open Learning (IDOL Admin).
Vidyanagari.
- 8) The Deputy Registrar, Admissions, Enrolment, Eligibility & Migration
Department (AEM),

Copy forwarded for information and necessary action to :-	
1	The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Dept)(AEM), dr@eligi.mu.ac.in
2	The Deputy Registrar, Result unit, Vidyanagari drresults@exam.mu.ac.in
3	The Deputy Registrar, Marks and Certificate Unit,. Vidyanagari dr.verification@mu.ac.in
4	The Deputy Registrar, Appointment Unit, Vidyanagari dr.appointment@exam.mu.ac.in
5	The Deputy Registrar, CAP Unit, Vidyanagari cap.exam@mu.ac.in
6	The Deputy Registrar, College Affiliations & Development Department (CAD), deputyregistrar.uni@gmail.com
7	The Deputy Registrar, PRO, Fort, (Publication Section), Pro@mu.ac.in
8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
9	The Deputy Registrar, Research Administration & Promotion Cell (RAPC), rapc@mu.ac.in
10	The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA) dy.registrar.tau.fort.mu.ac.in ar.tau@fort.mu.ac.in
11	The Deputy Registrar, College Teachers Approval Unit (CTA), concolsection@gmail.com
12	The Deputy Registrars, Finance & Accounts Section, fort draccounts@fort.mu.ac.in
13	The Deputy Registrar, Election Section, Fort drelection@election.mu.ac.in
14	The Assistant Registrar, Administrative Sub-Campus Thane, thanesubcampus@mu.ac.in
15	The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan, ar.seask@mu.ac.in
16	The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri, ratnagirisubcentre@gmail.com

Copy for information :-

1	P.A to Hon'ble Vice-Chancellor, vice-chancellor@mu.ac.in
2	P.A to Pro-Vice-Chancellor pvc@fort.mu.ac.in
3	P.A to Registrar, registrar@fort.mu.ac.in
4	P.A to all Deans of all Faculties
5	P.A to Finance & Account Officers, (F & A.O), camu@accounts.mu.ac.in

1	The Chairman, Board of Deans
2	The Dean, Faculty of Humanities,
3	Chairman, Board of Studies,
4	The Director, Board of Examinations and Evaluation, dboee@exam.mu.ac.in
5	The Director, Board of Students Development, dsd@mu.ac.in@gmail.com DSW directr@dsw.mu.ac.in
6	The Director, Department of Information & Communication Technology,
7	The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari, director@idol.mu.ac.in

As Per NEP 2020

University of Mumbai



Title of the program
M.Sc. (IT-Artificial Intelligence)

Syllabus for
Semester – Sem.- III & IV
Ref: GR dated 16th May, 2023 for Credit
Structure of PG

(With effect from the academic year 2024-25)

University of Mumbai



(As per NEP 2020)

Sr. No.	Heading	Particulars
1	Title of program O: _____ B	M.Sc. (IT-Artificial Intelligence)
2	Scheme of Examination R: _____	NEP 50% Internal 50% External, Semester End Examination Individual Passing in Internal and External Examination
3	Standards of Passing R: _____	40%
4	Credit Structure R: <u>SP-110B</u>	Attached herewith
5	Semesters	Sem. III & IV
6	Program Academic Level	6.5
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic Year	2024-25

Sign of Chairperson
Dr. Mrs. R.
Srivaramangai
Ad-hoc BoS (IT)

Sign of the
Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science &
Technology

Sign of Offg. Dean,
Prof. Shivram S. Garje
Faculty of Science &
Technology

5. Credit Structure of the program (Sem-I, II, III & IV)

Post Graduate Programs in University

Parishishta 1

R. SP-110B											
Yea r	Level	Sem (2yr)	Major				RM	OJT/FP	RP	Cum. Cr.	Degr ee
2	6.5	Sem III	2*4+2*2 + 2			4	-	-	(607)4	22	PG Degr ee after 3-yr UG or PG Degr ee after 4-yr UG
			Machine Learning(601)	TH	4	Blockchain(606a) (OR) Cloud Economics(606b) (OR) BioMedical Image Processing(606c)					
			Machine Learning(602)	PR	2						
			Robotic Processing Automation(603)	TH	4						
			Robotic Processing Automation(604)	PR	2						
			Human Computer Interaction(605)	TH	2						
		Sem IV	2*4+2*2			4	-	-	(616)6	22	
			Natural Language Processing(611)	TH	4	Augmented Reality & Virtual Reality(615a) (OR) Digital Image Forensics(615b) (OR) Edge Computing(615c)					
			Natural Language Processing(612)	PR	2						
			Deep Learning(613)	TH	4						
			Deep Learning(614)	PR	2						
Cum. Cr. For 1 Yr PG Degree			26			8			10	44	
Cum. Cr. For 2 Yr PG Degree			54			16	4	4	10	88	

Syllabus

**M.Sc. (IT-Artificial Intelligence)
(Sem. III & IV)**

Sem-III

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: 601 [Mandatory] Total Credits: 04 (60 Lecture Hrs) University assessment: 50 marks	Course Name: Machine Learning (Theory) Total Marks: 100 marks College/Department assessment: 50 marks
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Pre requisite:

- Sound knowledge of Python
- Sound knowledge of concepts in probability, statistics & mathematics

Course Objectives (COs)

To enable the students to:

- CO1: Understand the foundational concepts and terminology of machine learning, including supervised and unsupervised learning techniques.
- CO2: Grasp the theoretical underpinnings of various machine learning algorithms and methods, such as decision trees, Bayesian estimation, and reinforcement learning.
- CO3: Implement and apply machine learning algorithms to solve real-world problems, demonstrating proficiency in data pre-processing, model selection, and evaluation techniques.
- CO4: Evaluate and compare the performance of different machine learning models and techniques through rigorous experimentation and analysis of results.
- CO5: Design and develop advanced machine learning systems and solutions, incorporating ensemble methods, reinforcement learning, and experimental design principles.

MODULE I: Machine Learning Basics & Supervised Learning	(2 CREDITS)
Unit 1: Machine Learning Basics Introduction to Machine Learning & Supervised Learning: Introduction to Machine Learning, Types of Machine Learning, VC dimension, PAC Learning, Noise, Learning Multiple Classes, Regression, Model Selection and Generalization, Dimensions of a Supervised Machine Learning Algorithm Bayesian Decision Theory & Parametric Methods: Classification, Losses and Risks, Discriminant Functions, Utility Theory, Association Rules, Maximum Likelihood Estimation, Bias and Variance, The Bayes' Estimator, Parametric Classification, Regression, Bias/Variance Dilemma, Model Selection Procedures Multivariate Methods & Nonparametric Methods: Multivariate Data, Parameter Estimation, Estimation of Missing Values, Multivariate Normal Distribution, Multivariate Classification, Tuning Complexity, Discrete Features, Multivariate Regression, Nonparametric Density Estimation, Generalization to Multivariate Data, Nonparametric Classification, Condensed Nearest Neighbor, Nonparametric Regression: Smoothing Models, How to Choose the Smoothing Parameter	18 Hrs [OC1, OC2]
Unit 2: Supervised Learning Techniques Decision Trees: Univariate Trees, Classification Trees, Regression Trees, Pruning, Rule Extraction from Trees, Learning Rules from Data, Multivariate Trees Linear Discrimination & Kernel Machines: Generalizing the Linear Model, Geometry of the Linear Discriminant, Pairwise Separation, Parametric Discrimination Revisited, Gradient Descent, Logistic Discrimination, Discrimination by Regression, Optimal Separating Hyperplane, The Nonseparable Case: Soft Margin Hyperplane, v-SVM, Kernel Trick, Vectorial Kernels, Defining Kernels, Multiple Kernel Learning, Multiclass Kernel Machines, Kernel Machines for Regression, One-Class Kernel Machines Bayesian Estimation: Estimating the Parameter of a Distribution, Bayesian Estimation of the Parameters of a Function, Gaussian Processes	15 Hrs [OC3]
MODULE II : Unsupervised Learning, Ensemble Model Reinforcement Learning	(2 CREDITS)
Unit 3: Unsupervised Learning Dimensionality Reduction: Subset Selection, Principal Components Analysis, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis, Isomap, Locally Linear Embedding Clustering: Mixture Densities, k-Means Clustering, Expectation-Maximization Algorithm, Mixtures of Latent Variable Models, Supervised Learning after Clustering, Hierarchical Clustering, Choosing the Number of Clusters Hidden Markov Models: Discrete Markov Processes, Hidden Markov Models, Three Basic Problems of HMMs, Evaluation Problem, Finding the State Sequence, Learning	12 Hrs [OC4, OC5]

Model Parameters, Continuous Observations, The HMM with Input, Model Selection	
Unit 4: Ensemble Models and Reinforcement Learning Combining Multiple Learners: Generating Diverse Learners, Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging, Boosting, Mixture of Experts Revisited, Stacked Generalization, Fine-Tuning an Ensemble, Cascading Reinforcement Learning: Single State Case: K-Armed Bandit, Elements of Reinforcement Learning, Model-Based Learning - Value Iteration & Policy Iteration, Temporal Difference Learning, Generalization, Partially Observable States, The Setting, Example: The Tiger Problem Design and Analysis of Machine Learning Experiments: Factors, Response, and Strategy of Experimentation, Response Surface Design, Randomization, Replication, and Blocking, Guidelines for Machine Learning Experiments, Cross-Validation and Resampling Methods, Measuring Classifier Performance, Interval Estimation, Hypothesis Testing, Assessing a Classification Algorithm's Performance, Comparing Two Classification Algorithms, Comparing Multiple Algorithms: Analysis of Variance, Comparison over Multiple Datasets, Comparing Two Algorithms, Multiple Algorithms	15 Hrs [OC6,OC7, OC8]

References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Introduction to Machine Learning	Ethem Alpaydin	The MIT Press Cambridge	Third	2014
2.	Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow	Aurélien Géron	O'Reilly	Second	2019
3.	Introduction to Machine Learning with Python	Andreas C. Müller, Sarah Guido	O'Reilly	First	2017
4.	Machine Learning: The Art and Science of Algorithms that Make Sense of Data	Peter Flach	Cambridge University Press		2012
5.	Introduction to Statistical Machine Learning with Applications in R	Hastie, Tibshirani, Friedman	Springer	Second	2012

Course Outcomes (OCs)

Upon completion of this course, student will be able to:

- OC1. Demonstrate a deep understanding of the foundational concepts and terminology of machine learning, including supervised and unsupervised learning paradigms.
- OC2. Apply theoretical principles behind Bayesian decision theory, parametric, and nonparametric methods to solve classification and regression problems.
- OC3. Implement decision tree algorithms, linear discrimination techniques, and kernel machines for supervised learning tasks.
- OC4. Utilize dimensionality reduction and clustering techniques to analyse and interpret complex datasets in unsupervised learning scenarios.
- OC5. Understand the theoretical foundations of Hidden Markov Models and their applications in machine learning.
- OC6. Apply ensemble learning techniques such as bagging and boosting to improve model performance and robustness in prediction tasks.
- OC7. Implement and analyse reinforcement learning algorithms, including value iteration and policy iteration, to solve sequential decision-making problems.
- OC8. Evaluate the performance and generalization of machine learning models through rigorous experimentation and cross-validation techniques.

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code:602 [Mandatory]
Total Credits: 02 (60 Lecture Hrs)
University assessment: 25 marks

Course Name: Machine Learning Practical
Total Marks: 50 marks
College/Department assessment: 25 marks

Prerequisite:

1. Sound knowledge of Python
2. Sound knowledge of concepts in probability, statistics & mathematics

Course Objectives(COs):

To enable the students to:

CO 1: Gain a comprehensive understanding of fundamental machine learning algorithms, techniques, and methodologies.

CO 2: Acquire hands-on experience in preparing and pre-processing raw data for machine learning tasks, including handling missing data, feature scaling, and encoding categorical variables.

CO 3: Develop proficiency in implementing a variety of machine learning models, including regression, classification, clustering, ensemble learning, and neural networks.

CO 4: Explore advanced techniques for dimensionality reduction, to extract meaningful features from high-dimensional data.

CO 5: Understand the importance of model evaluation and selection techniques to assess the performance and generalization capability of machine learning models.

CO 6: Master the techniques of hyperparameter tuning and optimization to fine-tune machine-learning models for improved performance.

CO 7: Apply machine learning algorithms and techniques to real-world datasets and problems, developing practical skills in problem-solving, data analysis, and model deployment.

Prac No	Practical Description	2 CREDITS (60 hrs)
1.	Data Pre-processing	
a.	Implementing various methods for handling missing data on different datasets	3 [OC1]
b.	Usage of various feature scaling methods and its usage depending on the data.	2 [OC1]
c.	Implementing various methods for encoding categorical data.	2 [OC1]
2.	Regression	
a.	Implement simple linear regression.	2 [OC2]
b.	Implement multiple linear regression.	2 [OC2]
c.	Implement polynomial regression.	2 [OC2]
3.	Classification	
a.	Implement categorical classification.	2 [OC2]
b.	Implement logistic regression.	2 [OC2]
c.	Implement k-Nearest Neighbors (k-NN).	3 [OC2]
d.	Implement Support Vector Machines (SVM).	2 [OC2]
4.	Clustering	
a.	Implement K-means clustering.	3 [OC2]
b.	Implement Hierarchical clustering.	3 [OC2]
c.	Implement Density-based spatial clustering of applications with noise (DBSCAN).	3 [OC2]
5.	Dimensionality Reduction	
a.	Implement Principal Component Analysis (PCA).	3 [OC3]
b.	Implement t-Distributed Stochastic Neighbor Embedding (t-SNE).	3 [OC3]
c.	Implement Linear Discriminant Analysis (LDA).	2 [OC3]
6.	Ensemble Learning	
a.	Implement Random Forest.	2 [OC4]
b.	Implement Gradient Boosting Machines (GBM).	2 [OC4]
c.	Implement AdaBoost.	2 [OC4]

7.	Neural Networks	
a.	Implement Building a basic feedforward neural network & Back propagation algorithm.	2 [OC2]
8.	Model Evaluation	
a.	Implement Cross-validation.	2 [OC 5]
b.	Implement Confusion matrix.	2 [OC 5]
c.	Implement ROC curve and AUC score.	2 [OC 5]
9.	Hyperparameter Tuning	
a.	Implement Grid search.	2 [OC 5]
b.	Implement Random search.	2 [OC 5]
c.	Implement Bayesian optimization.	3 [OC 5]

References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Introduction to Machine Learning	Ethem Alpaydın	The MIT Press Cambridge	Third	2014
2.	Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow	Aurélien Géron	O'Reilly	Second	2019
3.	Introduction to Machine Learning with Python	Andreas C. Müller, Sarah Guido	O'Reilly	First	2017
4.	Machine Learning: The Art and Science of Algorithms that Make Sense of Data	Peter Flach	Cambridge University Press		2012
5.	Introduction to Statistical Machine Learning with Applications in R	Hastie, Tibshirani, Friedman	Springer	Second	2012

Course Outcomes (OCs)

Upon completion of this course, student will be able to:

- OC 1. Demonstrate proficiency in handling diverse datasets through effective preprocessing techniques
- OC 2. Build, analyze, and interpret various machine learning models
- OC 3. Gain proficiency in dimensionality reduction and feature extraction techniques
- OC 4. Demonstrate proficiency in ensemble learning methods
- OC 5. Evaluate and optimize various machine learning models

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: 603[Mandatory] Total Credits: 04 (60 Lecture Hrs) University assessment: 50 marks	Course Name: Robotic Process Automation Total Marks: 100 marks College/Department assessment: 50 marks
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Pre requisite:

1. Foundational understanding of programming concepts
2. Familiarity with variables, control flow, and data manipulation techniques

Course Objectives (COs)

To enable the students to:

- CO1 : To understand the basic concepts of Robotic Process Automation.
CO2 : To expose to the key RPA design and development strategies and methodologies.
CO3 : To learn the fundamental RPA logic and structure.
CO4 : To explore the Exception Handling, Debugging and Logging operations in RPA.
CO5 : To explore Employability and enterprise applications in RPA.

MODULE I:	(2 CREDITS)
Unit 1: Robotic Process Automation (RPA) Fundamentals Introduction of Robotic Process Automation (RPA), Evolution of RPA, Compare and contrast RPA from Automation - Benefits of RPA - Application of RPA, Components of RPA, UiPath Studio Overview. Robotic Process Automation Tools - Templates, User Interface, Domains in Activities, Workflow Files.	15 Hrs [OC1, OC2]
Unit 2: RPA Studio Activities and Workflow Components Sequence, Flowchart & Control Flow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making. Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, UiExplorer, Handling Events	15 Hrs [OC1, OC3]
MODULE II :	(2 CREDITS)
Unit 3: RPA Automation Concepts and Techniques Exception handling, Common exceptions, Logging- Debugging techniques, Collecting crash dumps, Error reporting. Code management and maintenance: Project organization, Nesting workflows, Reusability, Templates, Commenting techniques, State Machine.	15 Hrs [OC4, OC5]
Unit 4: a. RPA Deployment and Management : Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates. RPA Vendors - Open Source RPA b. Employability and enterprise applications in RPA : RPA and Its Role in Enterprises, Essential Technical Skills for RPA Professionals, Advanced RPA Development, Introduction to Orchestrator - Collaboration and Communication Skills, Employability Skills, Business Process Understanding, Open Source RPA and Future Trends, Capstone Project - Real-world Enterprise Automation	15 Hrs [OC1,OC6]

References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath Packt Publishing	Alok Mani Tripathi	PACKT		2018
0.	The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems	Tom Taulli	Apress publications		2020
0.	Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation	Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston	Amazon Asia-Pacific Holdings Private Limited		2018
0.	Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant	Richard Murdoch	Amazon Asia-Pacific Holdings Private Limited		2018

Course Outcomes(OCs)

1. Understand the basic concepts of Robotic Process Automation.
2. Enunciate the key distinctions between RPA and existing automation techniques and platforms.
3. Use UiPath to design control flows and work flows for the target process
4. Implement recording, web scraping and process mining by automation
5. Use UiPath Studio to detect, and handle exceptions in automation processes
6. Implement and use Orchestrator for creation, monitoring, scheduling, and controlling of automated bots and processes.

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: 604[Mandatory] Total Credits: 02 (60 Lecture Hrs) University assessment: 25 marks	Course Name: Robotic Process Automation Practical Total Marks: 50 marks College/Department assessment: 25 marks
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Prerequisite:

1. Sound knowledge of concepts in programming

Course Objectives (COs):

To enable the students to:

1. Enable the student to use the automation environment for different purposes
2. Apply knowledge of programming in automation using datatypes, operations, decision & looping statements
3. Learn to automate and improve automation by using recorder
4. Implement concepts like file automation, finding controls, triggering, screen scrapping & exception handling
5. Understand and apply concepts such as State machines and role of Orchestrator

Prac No	Practical Description	2 CREDITS (60 hrs)
1	a. Create a simple sequence based project.	4 hrs OC1
	b. Create a flowchart-based project.	4 hrs OC1
2	Automate UiPath Number Calculation (Subtraction, Multiplication, Division of numbers).	4 hrs OC2
	Create an automation UiPath project using different types of variables (number, datetime, Boolean, generic, array, data table)	5 hrs OC2
3	Create an automation UiPath Project using decision statements.	4 hrs OC3
	Create an automation UiPath Project using looping statements.	5 hrs OC3
	Consider an array of names. We have to find out how many of them start with the letter "a". Create an automation where the number of names starting with "a" is counted and the result is displayed.	4 hrs OC3
4	Create an automation to demonstrate recording	6 hrs OC4
	Create an UiPath Robot which can empty recycle bin solely on basis of recording.	4 hrs OC4
	Create an UiPath Robot which can empty a folder in Gmail solely on basis of recording.	4 hrs OC4
5	a. Create an application automating the read, write and append operation on excel file.	4 hrs OC5
	b. Automate the process to extract data from an excel file into a data table and vice versa	4 hrs OC5
6	Create an automation to Find different controls using UiPath.	4 hrs OC6
7	Demonstrate the following activities in UiPath: i. Mouse (click, double click and hover) ii. Type into	6 hrs OC7
8	Demonstrate the following events in UiPath: i. Element triggering event ii. Image triggering event iii. System Triggering Event	6 hrs OC8

9	Create an automation to demonstrate screen scraping using UiPath	4 hrs OC9
10	Create an automation to demonstrate the Exception handling in UiPath	4 hrs OC10
11	Create an automation to demonstrate use of State Machine in UiPath.	4 hrs OC11
12	Demonstrate the use of publish utility.	4 hrs OC12
13	Understand the role of orchestrator	4 hrs OC12

References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
2.	Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath Packt Publishing	Alok Mani Tripathi	PACKT		2018
1.	The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems	Tom Taulli	Apress publications		2020
1.	Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation	Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston	Amazon Asia-Pacific Holdings Private Limited		2018
1.	Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant	Richard Murdoch	Amazon Asia-Pacific Holdings Private Limited		2018

Course Outcomes(OCs):

Upon completing this course, the student will be able to:

- OC 1. Effectively apply the different types of projects sequence, flowchart, state machine
- OC 2. Use different data types and perform operations on them
- OC 3. Effectively use decision control and looping statements
- OC 4. Apply recorder in different scenarios
- OC 5. Understand & apply file automation: word, excel
- OC 6. Understand & apply find control methods
- OC 7. Understand & apply how to use mouse click & type into activities
- OC 8. Understand & apply concept of triggers
- OC 9. Understand & apply concept of screen scraping
- OC 10. Understand & apply concept of exception handling
- OC 11. Understand & apply concept of State Machines
- OC 12. Understand & apply concept orchestrator

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: 605[Mandatory] Total Credits: 02 (30 Lecture Hrs) University assessment: 25 marks	Course Name: Human Computer Interaction[Theory] Total Marks: 50 marks College/Department assessment: 25 marks
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Prerequisites:

1. Basic working of computers

Course Objectives (COs):

- CO 1. To gain an overview of Human-Computer Interaction (HCI)
- CO 2. Become familiar with the vocabulary associated with sensory and cognitive systems
- CO 3. Able to apply models from cognitive psychology to predicting user performance in various human-computer interaction tasks
- CO 4. To understand the social implications of technology and their ethical responsibilities as engineers in the design of technological systems.

MODULE I:	(2 CREDITS)
Unit 1: Foundations, Design Process a. The Human b. The Computer c. The Interaction d. Paradigms. e. Interaction Design Basics f. HCI in the software process g. Design Rules h. Implementation Support i. Evaluation techniques j. Universal Design k. User Support	15 Hrs [OC1-OC3]
MODULE II :	(2 CREDITS)
Unit 2: Models and Theories, Outside the Box 1. Cognitive Models 2. Socio-Organizational Issues And Stakeholder Requirements 3. Communication and Collaboration Models 4. Task Analysis 5. Dialog Notations and Design 6. Groupware 7. Ubiquitous Computing and Augmented realities 8. Web designing and hypertext	15 Hrs [OC4-OC6]

References:

- 1) Human – Computer Interaction. Alan Dix, Janet Fincay, Gre Goryd, Abowd, Russell Bealg, Pearson Education
- 2) The essential guide to user interface design, Wilbert O Galitz, Wiley Dream Tech.
- 3) Human –Computer Interaction, D. R. Olsen, Cengage Learning

Course Outcomes (OCs):

On Completion of the course the student will be able to:

- OC1 HCI and principles to interaction design.
- OC2 Do screen planning and screen design.
- OC3 Ability to design Windows
- OC4 Apply HCI and principles to interaction design.
- OC5 Ability to conduct HCI patterns evaluation
- OC6 Design certain tools for visually challenging or PH people.

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: 606a [Elective] Total Credits: 04 (60 Lecture Hrs) University assessment: 50 marks	Course Name: Blockchain (Theory) Total Marks: 100 marks College/Department assessment: 50 marks
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Prerequisite:

A basic understanding of the following concepts would be beneficial:

1. Computer networks and distributed systems
2. Cryptography fundamentals

Course Objectives (COs)

To enable the students to:

- CO1: Explain the fundamental concepts and underlying technologies of blockchain.
CO2: Analyse the benefits and challenges associated with blockchain adoption.
CO3: Analyse the potential benefits and limitations of blockchain in different use cases.
CO4: Critically evaluate the role of blockchain in addressing the double-spending problem and ensuring secure ownership.
CO5: Become familiar with leading blockchain platforms like Bitcoin and Ethereum, along with their functionalities.
CO6: Explore the emerging trends in blockchain, including Web3 and Hyperledger.

MODULE I: Fundamentals of Blockchain	(2 CREDITS)
Unit 1: Technical Foundations and Need for Blockchain a. Thinking in Layers and Aspects: Layers of a Software System, Considering Two Layers at the Same Time, Integrity. b. Seeing the Big Picture: A Payment System, Two Types of Software Architecture, The Advantages of Distributed Systems, The Disadvantages of Distributed Systems, Distributed Peer-to-Peer Systems, Mixing Centralized and Distributed Systems, Identifying Distributed Systems, The Purpose of the Blockchain. c. Recognizing the Potential: How a Peer-to-Peer System Changed a Whole Industry, The Potential of Peer-to-Peer Systems, Terminology, and the Link to the Blockchain. d. Discovering the Core Problem: Trust and Integrity in Peer-to-Peer Systems, The Core Problem to Be Solved by the Blockchain. e. Disambiguating the Term: Four ways to define the blockchain, Provisional Definition, The Role of Managing Ownership. f. Understanding the Nature of Ownership, Ownership and Witnesses, Foundations of Ownership, A Short Detour to Security, Purposes and Properties of a Ledger, Ownership and the Blockchain. g. Spending Money Twice: The Double Spending Problem, How to Solve the Double Spending Problem.	15 Hrs [OC1, OC2, OC3, OC4]

Unit 2: Working of Blockchain - Planning the Blockchain: Starting Point, The Path to Follow. - Documenting Ownership: The Goal, The Challenge, The Idea, A Short Detour to Inventory and Transaction Data, How It Works, Importance of Ordering, Integrity of the Transaction History. - Hashing Data: The Goal, How it Works, Trying It Out Yourself, Patterns of Hashing Data. - Hashing in the Real World: Comparing Data, Detecting Changes in Data, Referring to Data in a Change-Sensitive Manner, A Schematic Illustration, Storing Data in a Change-Sensitive Manner, Causing Time-Consuming Computations. - Identifying and Protecting User Accounts: A gentle introduction to cryptography, A Short Detour to Cryptography, Symmetric Cryptography, Asymmetric Cryptography, Asymmetric Cryptography in the Real World, Asymmetric Cryptography in the Blockchain. - Authorizing Transactions: Utilizing the digital equivalent to handwritten signatures, A Short Detour to Digital Signatures, How It Works, Why It Works. - Storing Transaction Data: Building and maintaining a history of transaction data, Transforming a Book into a Blockchain-Data-Structure, The Blockchain-Data-Structure, Storing Transactions in the Blockchain-Data-Structure.	15 Hrs [OC2, OC3, OC4, OC5]
MODULE II : Blockchain Frameworks	(2 CREDITS)
Unit 3: Cryptocurrencies - Introducing Bitcoin: Bitcoin, Digital keys and Addresses, Transactions, Blockchain, Mining. - Ethereum 101: Introduction, Ethereum – bird’s eye view, The Ethereum network, Components of the Ethereum ecosystem.	15 Hrs [OC3, OC4, OC5, OC6]
Unit 4: Web3 and Hyperledger - Introducing Web3: Web3, Contract Deployment, POST requests, The HTML and JavaScript frontend, Development frameworks. - Hyperledger: Projects under Hyperledger, Hyperledger as a protocol, The reference architecture, Fabric, Sawtooth Lake, Corda.	15 Hrs [OC3, OC4, OC5, OC7, OC8]

References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
3.	Blockchain Basics – A Non-Technical Introduction in 25 steps	Daniel Drescher	Apress	First	2017
2.	Mastering Blockchain	Imran Bashir	Packt Publishing	Second	2018
2.	Bitcoin and Cryptocurrency Technologies - A Comprehensive Introduction	Arvind Narayanan, et.al.	Princeton University Press	First	2016
3.	Hands-On Blockchain with Hyperledger	Nitin Gaur, et.al.	Packt Publishing	First	2018

Course Outcomes (OCs)

- OC 1. Describe the layered architecture of blockchain systems and their interconnectedness.
- OC 2. Explain the process of registering and managing ownership on a blockchain network.
- OC 3. Explain the double-spending problem and how blockchain technology addresses it.
- OC 4. Describe the process of designing and implementing a blockchain network, including data ownership, hashing, and transaction authorization.
- OC 5. Evaluate the security features employed in blockchain systems for user authentication and transaction authorization.
- OC 6. Explain the fundamentals of Bitcoin and Ethereum, including their architecture and core functionalities.
- OC 7. Explain the concept of Web3 and its role in building decentralized applications.
- OC 8. Describe the functionalities, purpose, and applications of Hyperledger Projects in blockchain ecosystems.

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: (606b) [Elective] Total Credits: 04 (60 Lecture Hrs) University assessment: 50 marks	Course Name: Cloud Economics (Theory) Total Marks: 100 marks College/Department assessment: 50 marks
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Pre requisite:

4. Basic knowledge of Cloud Computing.

Course Objectives (COs)

To enable the students to:

CO1: Understand cloud computing models, deployment strategies, and business impact metrics.

C02: Master FinOps fundamentals, including data-driven decisions, real-time feedback, and team collaboration.

CO3: Develop skills in managing cloud expenses through usage reduction, rightsizing, and commitment-based discounts.

C04: Integrate FinOps strategies with sustainability and broader business objectives, fostering a cost-aware culture.

CO5: Implement FinOps in containerized and serverless architectures, optimizing costs and collaborating effectively with engineering teams.

MODULE I:	(2 CREDITS)
Unit 1: a. What Is Cloud Computing? —The Journey to Cloud - Cloud Computing Defined NIST Definition of Cloud Computing, Characteristics, Clouds Cloud Service Models, Cloud Deployment Models, Metrics That Matter—What You Need to Know - Business Value Measurements, Indirect Metrics, Direct Metrics, Other Direct Metrics. Sample Case Studies—Applied Metrics -Total Cost of Ownership, Software Licensing: SaaS, TCO with Software as a Service, Software as a Service Cost Comparison Disaster Recovery and Business Continuity: IaaS Cost-Benefit Analysis for Server Virtualization, Disaster Recovery and Business Continuity (IaaS) -Summary Platform as a Service. The Cloud Economy—The Human-Economic Impact of Cloud Computing - Technological Revolutions and Paradigm Change, The Course of Human Development, The United Nations Human Development Index, Cloud Computing as an Economic Enabler, Cloud Computing and Unemployment, Cloud Computing and the Environment Meritocratic Applications of Cloud Computing, Alternative Metrics and Measures of Welfare, The Economic Future of Cloud Computing. b. Introducing FinOps -What Is FinOps? Defining the Term “FinOps”, The FinOps Hero’s Journey, Where Did FinOps Come from? Data-Driven Decision Making, Real-Time Feedback (aka the “Prius Effect”), Core Principles of FinOps , When Should You Start FinOps? , Starting with the End in Mind: Data-Driven Decision Making , Why FinOps? - Use Cloud for the Right Reasons, Cloud Spend Keeps Accelerating, The Impact of Not Adopting FinOps, Informed Ignoring: Why Start Now? Cultural Shift and the FinOps Team - Deming on Business Transformation, Who Does FinOps? Why a Centralized Team? The FinOps Team Doesn’t Do FinOps, The Role of Each Team in FinOps, Executives and Leadership, Engineering and Developer, Finance Procurement and Sourcing Product or Business Teams FinOps Practitioners A New Way of Working Together, Where Does Your FinOps Team Report? Understanding Motivations, Engineers, Finance People, Executives and Leadership, Procurement and Sourcing People, FinOps Throughout Your Organization Hiring for FinOps, FinOps Culture in Action, Difficulty Motivating People Is Not New, Contributors to Action, Detractors from Action, Tipping the Scales in Your Favor, c. The Language of FinOps - Defining a Common Lexicon , Defining the Basic Terms, Defining Finance Terms for Cloud Professionals , Abstraction Assists Understanding , Cloud Language Versus Business Language , Creating a Universal Translator Between Your DevOps and Finance Teams , The Need to Educate All the Disciplines , Benchmarking and Gamification , Anatomy of the Cloud Bill- Types of Cloud Bill , Cloud Billing Complexity , Basic Format of Billing Data, Time, Why Do You Punish Me?, Sum of the Tiny Parts , A Brief History of Cloud Billing Data , The Importance of Hourly Data , A Month Is Not a Month . A Dollar Is Not a Dollar . Two Levers to Affect Your Bill . Who Should Avoid	15 Hrs [OC1,OC2]

Costs and Who Should Reduce Rates? , Centralizing Rate Reduction , Why You Should Decentralize Usage Reduction .	
Unit 2: a. Adopting FinOps- A Confession , Different Executive Pitches for Different Levels , Starting Pitch , Advancing Pitch , Sample Headcount Plan for Advancing a FinOps Team , Pitching the Executive Sponsor , Playing to Your Audience, Key Personas That the Driver Must Influence , CEO Persona , CTO/CIO Persona , CFO Persona , Engineering Lead Persona , Roadmap for Getting Adoption of FinOps - Stage 1: Planning for FinOps in an Organization , Stage 2: Socializing FinOps for Adoption in an Organization , Stage 3: Preparing the Organization for FinOps , Type of Alignment to the Organization , Full Time, Part Time, Borrowed Time: A Note on Resources, A Complex System Designed from Scratch Never Works , The FinOps Foundation Framework- An Operating Model for Your Practice , The Framework Model - Principles , Personas , Maturity , Phases , Domains and Capabilities - Structure of a Domain , Structure of Capabilities , Adapting the Framework to Fit Your Needs , Connection to Other Frameworks/Models . b. The UI of FinOps-Build Versus Buy Versus Native- When to Use Native Tooling, When to Build, Why to Buy, Operationalized Reporting, Data Quality, Perfect Is the Enemy of Good, Report Tiering, Rolling Out Changes, The Universal Report, Accessibility, Color, Visual Hierarchy, Usability and Consistency, Language, Consistency of Color and Visual Representation ,Recognition Versus Recall, Psychological Concepts ,Anchoring Bias ,Confirmation Bias , The Von Restorff Effect , Hick’s Law , Perspectives on Reports -Personas Maturity Multicloud , Putting Data in the Path of Each Persona - Data in the Path of Finance , Data in the Path of Leadership , Data in the Path of Engineers ,Connecting FinOps to the Rest of the Business Seek First to Understand, The FinOps Lifecycle- The Six Principles of FinOps -#1: Teams Need to Collaborate, #2: Decisions Are Driven by the Business Value of Cloud, #3: Everyone Takes Ownership of Their Cloud Usage, #4: FinOps Reports Should Be Accessible and Timely, #5: A Centralized Team Drives FinOps, #6: Take Advantage of the Variable Cost Model of the Cloud. The FinOps Lifecycle-Inform, Optimize, Operate. Considerations, Where Do You Start? You Don’t Have to Find All the Answers. c. The FinOps Lifecycle- The Six Principles of FinOps -#1: Teams Need to Collaborate, #2: Decisions Are Driven by the Business Value of Cloud, #3: Everyone Takes Ownership of Their Cloud Usage, #4: FinOps Reports Should Be Accessible and Timely, #5: A Centralized Team Drives FinOps, #6: Take Advantage of the Variable Cost Model of the Cloud. The FinOps Lifecycle-Inform, Optimize, Operate. Considerations, Where Do You Start? You Don’t Have to Find All the Answers. Inform Phase: Where Are You Right Now-Data Is Meaningless Without Context, Seek First to Understand, Organizational Work During This Phase, Transparency and the Feedback Loop, Benchmarking Team Performance, What Great Looks Like. Allocation: No Dollar Left Behind- Why Allocation Matters, Amortization: It’s Accrual World, Creating Goodwill and Auditability with Accounting, The “Spend Panic” Tipping Point, Spreading Out Shared Costs, Chargeback Versus Showback, A Combination of Models Fit for Purpose, Accounts, Tagging, Account Organization Hierarchies, The Showback Model in Action, Chargeback and Showback Considerations. Tags, Labels, and Accounts, - Tag- and Hierarchy-Based Approaches , Getting Started with Your Strategy , Communicate Your Plan , Keep It Simple , Formulate Your Questions , Comparing the Allocation Options of the Big Three , Comparing Accounts and Folders Versus Tags and Labels , Organizing Accounts and Projects into Groups , Tags and Labels: The Most Flexible Allocation Option , Using Tags for Billing , Getting Started Early with Tagging , Deciding When to Set Your Tagging Standard , Picking the Right Number of Tags , Working Within Tag/Label Restrictions, Maintaining Tag Hygiene , Reporting on Tag Performance , Getting Teams to Implement Tags , Accurate Forecasting- The State of Cloud Forecasting, Forecasting Methodologies, Forecasting Models, Cloud Forecasting Challenges, Manual Versus Automated Forecasts, Inaccuracies, Granularity, Forecast Frequency, Communication, Future Projects, Cost Estimation, Impacts of Cost Optimization on Forecasts, Forecast and Budgeting, The Importance of Managing Teams to Budgets.	15 Hrs [OC2, OC3]
MODULE II :	(2 CREDITS)
Unit 3:	

a. Optimize Phase: Adjusting to Hit Goals- Why Do You Set Goals? , The First Goal Is Good Cost Allocation ,Is Savings the Goal? , The Iron Triangle: Good, Fast, Cheap ,Hitting Goals with OKRs -OKR Focus Area #1: Credibility ,OKR Focus Area #2: Maintainable ,OKR Focus Area #3: Control ,Goals as Target Lines ,Budget Variances ,Using Less Versus Paying Less .Using Less: Usage Optimization-The Cold Reality of Cloud Consumption, Where Does Waste Come from? ,Usage Reduction by Removing/Moving ,Usage Reduction by Resizing (Rightsizing) ,Common Rightsizing Mistakes ,Relying on Recommendations That Use Only Averages or Peaks ,Failing to Rightsized Beyond Compute ,Not Addressing Your Resource “Shape” ,Not Simulating Performance Before Rightsizing ,Hesitating Due to Reserved Instance Uncertainty ,Going Beyond Compute: Tips to Control Cloud Costs, Block Storage ,Object Storage, Networking ,Usage Reduction by Redesigning ,Scaling ,Scheduled Operations ,Effects on Reserved Instances ,Benefit Versus Effort ,Serverless Computing ,Not All Waste Is Waste ,Maturing Usage Optimization ,Advanced Workflow: Automated Opt-Out Rightsizing, Tracking Savings. Paying Less: Rate Optimization-Compute Pricing, On-Demand/Pay-As-You-Go, Spot Resource Usage, Commitment-Based Discounts, Storage Pricing, Volume/Tiered Discounts, Usage-Based, Time-Based, Negotiated Rates, Custom Pricing, Seller Private Offers, BYOL Considerations. b. Understanding Commitment-Based Discounts-Introduction to Commitment-Based Discounts, Commitment-Based Discount Basics ,Compute Instance Size Flexibility, Conversions and Cancellations ,Overview of Usage Commitments Offered by the Big Three ,Amazon Web Services ,What Does an RI Provide?,AWS Commitment Models,AWS Reserved Instance ,Member Account Affinity .Standard Versus Convertible RIs ,Instance Size Flexibility ,AWS Savings Plans ,Savings Bundles ,Microsoft Azure ,Azure Reservations ,Instance Size Flexibility, Azure Savings Plans ,Google Cloud ,Google Committed Use Discounts ,Paying for Cores, Not Hours, in Google ,Google Billing and Sharing CUDs ,Google Billing Account and Ownership ,Applying Google CUDs in a Project ,Google Flexible Committed Use Discounts. c. Building a Commitment-Based Discount Strategy- Common Mistakes ,Steps to Building a Commitment-Based Discount Strategy ,Step 1: Learn the Fundamentals of Each Program ,Step 2: Understand Your Level of Commitment to Your Cloud Service Provider ,Step 3: Build a Repeatable Commitment-Based Discount Process ,Step 4: Purchase Regularly and Often, Step 5: Measure and Iterate ,Step 6: Allocate Up-Front Commitment Costs Appropriately ,How to Manage the Commitment Strategy ,Purchasing Commitments Just-in-Time ,When to Rightsize Versus Commit ,The Zone Approach ,Who Pays for Commitments? , Strategy Tips .	15 Hrs [OC4, OC,]
Unit 4: a. Sustainability: FinOps Partnering with GreenOps-What Are Cloud Carbon Emissions? Scope 1, 2, and 3 Emissions Are Cloud Providers Green? -Access, Completeness, Granularity, Partnering with Engineers on Sustainability, FinOps and GreenOps Better Together? GreenOps Remediations, Avoid FinOps Working Against GreenOps. Operate: Aligning Teams to Business Goals- Achieving Goals, Staffing and Augmenting Your FinOps Team, Processes, Onboarding, Responsibility, Visibility, Action, How Do Responsibilities Help Culture? Carrot Versus Stick Approach, Handling Inaction, Putting Operate into Action. Automating Cost Management-What Is the Outcome You Want to Achieve? Automated Versus Manual Tasks, Automation Tools, Costs, Other Considerations, Tooling Deployment Options, Automation Working, Together, Integration, Automation Conflict, Safety and Security, how to Start, what to Automate, Tag Governance, Scheduled Resource Start/Stop, Usage Reduction. Metric-Driven Cost Optimization- Core Principles, Automated Measurement, Targets, Achievable Goals, Data Driven, Metric-Driven Versus Cadence-Driven Processes, Setting Targets, Taking Action, Bring It All Together, b. FinOps for the Container World-Containers 101, The Move to Container Orchestration, The Container FinOps Lifecycle, Container Inform Phase, Cost Allocation, Container Proportions, Tags, Labels, and Namespaces, Container Optimize Phase ,Cluster Placement ,Container Usage Optimization ,Server Instance Rate Optimization ,Container Operate Phase ,Serverless Containers . Partnering with Engineers to Enable FinOps-Integrating Us with Them, What’s on the Mind of the	15 Hrs [OC5, OC6,]

Engineer? ,Constraints and the Solving of Hard Problems ,Principles for Enabling Cost-Efficient Engineering -#1: Maximize Value Rather Than Reduce Cost ,#2: Remember That We Are on the Same Team ,#3: Prioritize Improving Communication ,#4: Introduce Financial Constraints Early in the Product Development ,#5: Enablement, Not Control ,#6: Leadership Support Isn't Helpful, It Is Essential ,Data in the Path of the Engineer ,Models for Partnering with Engineering Teams ,Direct Contribution ,Indirect Collaboration ,Indirect Collaboration with Targeted Contribution . Connectivity to Other Frameworks-Total Cost of Ownership, working with Other Methodologies and Frameworks, Find Out Who's Out There, Make Friends and Share Goals, Share Influence, Terminology, and Processes, Share Infrastructure, Share Knowledge. FinOps Nirvana: Data-Driven Decision Making-Unit Economics and Metrics -Unit Economics Don't Have to Be About Revenue, Calculating Unit Economic Metrics, Spending Is Fine, Wasting Is Not, Activity-Based Costing, Coming Back to the Iron Triangle, What's Missing from the Equation? When Have You Won at FinOps?

References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
4.	The Economics of Cloud Computing	Bill Williams	Cisco Press		2012
3.	Cloud FinOps Collaborative, Real-Time Cloud Value Decision Making	J.R. Storment and Mike Fuller	O'Reilly Media, Inc	Second	2023
4.	Efficient Cloud FinOps: A Practical Guide to Cloud Financial Management and Optimization with AWS, Azure, and GCP	Alfonso San Miguel Sánchez and Danny Obando García	Packt Publishing		2024
2.	Measuring the Business Value of Cloud Computing (Palgrave Studies in Digital Business & Enabling Technologies)	Theo Lynn, John G. Mooney, Pierangelo Rosati, Grace Fox	Springer Nature Switzerland AG	First	2020
0.					

Course Outcomes(OCs)

Upon completing this course, students will gain:

- OC1: A comprehensive understanding of cloud computing, its service and deployment models, and key metrics for evaluating cloud economics.
- OC2: Insights into the principles and practices of FinOps, including data-driven decision-making, cost optimization, and organizational alignment.
- OC3: Practical knowledge on adopting and implementing FinOps within an organization, focusing on executive pitching, cultural shifts, and framework application.
- OC4: Skills to optimize cloud usage and spending through effective goal setting, usage, and rate optimization strategies.
- OC5: Awareness of sustainability in cloud operations and the integration of FinOps with GreenOps for environmentally friendly practices.
- OC6: Proficiency in automating cost management processes and applying FinOps principles in containerized environments, fostering collaboration between engineering and finance teams for optimized cloud spending.

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: (606c) [Elective] Total Credits: 04 (60 Lecture Hrs) University assessment: 50 marks	Course Name: BioMedical Image Processing (Theory) Total Marks: 100 marks College/Department assessment: 50 marks
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Pre requisite:

1. Sound Knowledge fundament concept of Digital Image Processing
2. Sound knowledge of concepts in probability, statistics & mathematics
3. Sound knowledge of Machine Learning and Deep Learning techniques

Course Objectives (COs)

To enable the students to:

CO1: Gain in-depth knowledge of medical image analysis techniques.

CO2: Understand various machine learning and deep learning models used in healthcare applications.

CO3: Develop skills in signal processing, image processing, and data analysis.

CO4: Learn to apply advanced algorithms for disease detection and diagnosis.

CO5: Enhance problem-solving abilities and critical thinking skills in the context of healthcare and medical imaging.

CO6: Explore future research directions and potential applications in the field of medical image analysis.

MODULE I:	(2 CREDITS)
Unit 1: Introduction to Medical Image Analysis, Image Denosing Technique a. An Introduction to Medical Image Analysis in 3D: Introduction, Comparison Between 2D and 3D Techniques in Medical Imaging, Importance of 3D Medical Image, Medical Imaging Types and Modalities, Computer Vision System Works in 3D Image Analysis, Various Techniques in 3D Image Processing in Medical Imaging, Types of Medical Imaging Compressed by 3D Medical Visualization ,3D Ultrasound Shortens. The Imaging Development Conclusion b. Automated Epilepsy Seizure Detection from EEG Signals Using Deep CNN Model: Introduction Materials and Methodology – Dataset, Normalization, Convolution Neural Network (CNN). Result and Discussions - Experiment 1: 10-Fold Cross Validation on 90:10 Ratio, Experiment 2: Training and Testing Ratio Variation, Conclusion c. Medical Image De-Noising Using Combined Bayes Shrink and Total Variation Techniques: Introduction, Literature Review, Theoretical Analysis- Median Modified Wiener Filter, Wavelet Transform, Dual Tree Complex Wavelet Transform, Sure Shrink, Bayes Shrink, Neigh Shrink, DTCWT Based De-Noising Using Adaptive Thresholding. Total Variation Technique. Pixel Level DTCWT Image Fusion Technique. Performance Evaluation Parameters - Peak Signal to Noise Ratio, Structural Similarity Index Matrix. Methodology, Results and Discussion, Conclusions and Future Scope	15 Hrs [OC1, OC2, OC 11 OC12]
Unit 2: Medical Image Diagnosis, Medical Image Fusion and Medical Image Applications a. Detection of Nodule and Lung Segmentation Using Local Gabor XOR Pattern in CT Images: Introduction, Histories, Concepts. Causes for Lung Cancer- Smoking, Familial Predisposition Lung Diseases, Prior Tale Containing Stroke Cancer, Air Pollution, Exposure as Far as Engine Exhaust, Types Containing Tumour, Signs and Symptoms of Lung Cancer. Solution Methodology with Mathematical Formulations - Feature Extraction, Modified Area Starting to Be Algorithm, Gridding, Selection of Seed Point. Morphological Operation, Conclusions and Future Work b. Medical Image Fusion Using Adaptive Neuro Fuzzy Inference System: Introduction Overview- Digital Image, Types of Digital Images -Binary Images, Grayscale Image, Color Image. Medical Imaging Type - CT Images, MRI Image. Image Fusion -Some Meanings of Fusion, Applications of Image Fusion, Medical Image Fusion. Literature Survey -A Brief History about Literature Survey. Solution Methodology -Fuzzy Logic, Fuzzy Set, Membership Functions, Fuzzy Inference System. Proposed Methodology - Applying to ANFIS, ANFIS Rule, RULES: Merge Color Channel, Result and Discussion - Simulation Result, Performance Analysis. Conclusion and Future Scope, Future Scope c. Medical Imaging in Healthcare Applications: Introduction Image Modalities - PET Scan, Ultrasound, MRI Scan, CT Scan. Recent Trends in Healthcare Technology, Scope	15 Hrs [OC3, OC4, OC5, OC 11 OC12]

for Future Work, Conclusions Classification of Diabetic Retinopathy by Applying an Ensemble of Architectures: Introduction - Literature Survey. Method and Data - Dataset Used, Augmentation of Dataset, Partition of Dataset, Evaluation Metrics, Method. Results. Conclusion	
MODULE II :	(2 CREDITS)
Unit 3: Compression and decompression techniques, different machine learning technique for detection of various diseases . a. Compression of Clinical Images Using Different Wavelet Function: Introduction: Background and Need of Compression, Terminology Utilized for Implementation. Proposed Algorithm -Calculation for Picture Compression Utilizing Wavelet Input Image Compression Decompression and Filters Compression Image Reconstruction, Performance Analysis Implementation and Result- Analysis of CT Scan Images Wavelet Haar Function Is Used. Conclusion b. PSO-Based Optimized Machine Learning Algorithms for the Prediction of Alzheimer's Disease: Introduction, Related Work- Material and Methods. Proposed Workflow Database Data Pre-processing. Particle Swarm Optimization (PSO) Techniques - Machine Learning Models Experimental Results, Discussion, Conclusion c. Parkinson's Disease Detection Using Voice Measurements: Introduction. Literature Survey - Parkinson's Syndromes, Symptoms, Causes, Threat Causes, Complications. Methodologies Used in Present Work - Machine Learning (ML) and Artificial Intelligence (AI), Ensemble Learning, Advantages, Data Drive Machine Learning, Architecture. Proposed System Testing- Type of Testing, Integration Testing, Functional Testing, Conclusion and Future Enhancements	15 Hrs [OC6, OC7, OC8, OC 11 OC12]
Unit 4: Different machine learning technique for Speech Impairment, Lung and Nodule. a. Speech Impairment Using Hybrid Model of Machine Learning: Introduction, Types of Classifier , Naive Bayes (Classifier), Support Vector Machine (SVM), K-Nearest Neighbor (KNN), Decision Tree Random Forest, XGBoost, Extra Trees. Related Work. Proposed Work, Results and Discussions, Conclusion b. Advanced Ensemble Machine Learning Model for Balanced BioAssays: Introduction, Related Work, Proposed Work, Ensemble Classification. Experimental Investigation- Dataset Report, Experimental Setting, Results - Assessment of Results, Assessment of the Model on the Dataset. Conclusion c. Lung Segmentation and Nodule Detection in 3D Medical Images Using Convolution Neural Network: Introduction, Review of Literature Rationale of the Study - Morphological Processing of the Digital Image, Objectives of Study Proposed Methodology -Evaluation Results for Medical Image Handling, False Positive Rate (FPR), False Negative Rate (FNR), Sensitivity, Specificity, Accuracy, Expected Outcome of Research Work, Conclusion and Future work	15 Hrs [OC9, OC10, OC 11 OC12]

References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
5.	Artificial Intelligence and Machine Learning in 2D/3D Medical Image Processing	Rohit Raja, Sandeep Kumar, Shilpa Rani, and K. Ramya Laxmi	CRC Press	First	2021
4.	Biomedical Signal and Image Processing with Artificial Intelligence	Chirag Paunwala, Mita Paunwala, Rahul Kher, Falgun Thakkar, Heena Kher, Mohammed Atiquzzaman and Norliza Mohd. Noor	EAI/Springer Innovations in Communication and Computing		2023
5.	Digital Image Processing for Medical	G. Dougherty	Cambridge University Press		2009

	Applications				
3.	Medical Image Analysis	Atam P. Dhawan	John Wiley & Sons, Inc	Second	2011

Course Outcomes(OCs)

Upon completing this course, students will:

OC1: Understand 3D Medical Image Analysis: Learn the differences between 2D and 3D techniques, the importance of 3D medical imaging, and various processing techniques.

OC2: Develop Skills in Deep Learning: Gain proficiency in using Deep Convolutional Neural Networks (CNN) for automated epilepsy seizure detection and medical image de-noising.

OC3: Learn Image Processing Techniques: Acquire knowledge in nodule detection, lung segmentation, and medical image fusion using advanced methods like Gabor XOR pattern and Adaptive Neuro Fuzzy Inference System (ANFIS).

OC4: Enhance Knowledge in Healthcare Applications: Understand the application of medical imaging in healthcare, recent trends, and the classification of diabetic retinopathy using ensemble architectures.

OC5: Master Compression Techniques: Learn about compression of clinical images using different wavelet functions and its implementation for CT scan images.

OC6: Explore Predictive Models: Gain insights into the prediction of Alzheimer's disease using PSO-based optimized machine learning algorithms and Parkinson's disease detection using voice measurements.

OC7: Develop Machine Learning Skills: Acquire skills in classifier models (e.g., Naive Bayes, SVM, KNN) for speech impairment detection and ensemble classification for balanced bioassays.

OC8: Gain Practical Experience: Apply learned concepts through methodologies, experimental results, and discussions in various medical imaging and disease detection scenarios.

OC9: Analyze Performance Metrics: Evaluate performance using metrics like Peak Signal to Noise Ratio, Structural Similarity Index Matrix, False Positive Rate (FPR), False Negative Rate (FNR), Sensitivity, Specificity, and Accuracy.

OC10: Explore Future Scope: Understand the future scope and potential enhancements in medical image analysis, disease detection, and healthcare applications.

OC11: Develop Critical Thinking: Enhance problem-solving abilities and critical thinking skills in the context of medical imaging and healthcare technology.

OC11: Prepare for Research and Innovation: Be prepared for further research and innovation in the field of medical image analysis, machine learning, and healthcare technology.

Sem-IV

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: 611[Mandatory] Total Credits: 04 (60 Lecture Hrs) University assessment: 50 marks	Course Name: Natural Language Processing (Theory) Total Marks: 100 marks College/Department assessment: 50 marks
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Pre requisites:

1. Sound knowledge of Python
2. Sound knowledge of concepts in probability, statistics & mathematics
3. Sound Knowledge of Artificial Intelligence

Course Objectives (COs)

To enable the students to:

- CO 1. The prime objective of this course is to introduce the learners to the field of Language Computing and its applications ranging from classical era to modern context.
- CO 2. To provide understanding of various NLP tasks and NLP abstractions such as Morphological analysis, POS tagging, concept of syntactic parsing, semantic analysis.
- CO 3. To provide knowledge of different approaches/algorithms for carrying out NLP tasks.
- CO 4. To highlight the concepts of Language grammar and grammar representation in Computational Linguistics.
- CO 5. To understand various parsing approaches.

MODULE I:	(2 CREDITS)
Unit 1: Introduction Natural language vs. programming language, The magic, Practical applications, Language through a computer's "eyes", word order and grammar, A chatbot natural language pipeline Language Processing and Python: Computing with Language, Closer Look at Python: Texts as Lists of Words, Computing with Language: Simple Statistics, Automatic Natural Language Understanding Accessing Text Corpora and Lexical Resources: Accessing Text Corpora, Conditional Frequency Distributions, Reusing Code, Lexical Resources, WordNet Processing Raw Text: Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions, Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation Formatting: From Lists to Strings	15 Hrs [OC1, OC2, OC3, OC4, OC5]
Unit 2: Categorizing and Tagging Words: Using a Tagger, Tagged Corpora, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation-Based Tagging, How to Determine the Category of a Word Learning to Classify Text: Supervised Classification, Further Examples of Supervised Classification, Evaluation, Decision Trees, Naive Bayes Classifiers, Maximum Entropy Classifiers, Modelling Linguistic Patterns, Extracting Information from Text: Information Extraction, Chunking,	15 Hrs [OC6, CO7, OC8, OC9, OC10]

Developing and Evaluating Chunkers, Recursion in Linguistic Structure, Named Entity Recognition, Relation Extraction	
MODULE II :	(2 CREDITS)
Unit 3: Analyzing Sentence Structure: Some Grammatical Dilemmas, What's the Use of Syntax?, Context-Free Grammar, Parsing with Context-Free Grammar, Dependencies and Dependency Grammar, Grammar Development Building Feature-Based Grammars: Grammatical Features, Processing Feature Structures, Extending a Feature-Based Grammar Analyzing the Meaning of Sentences: Natural Language Understanding, Propositional Logic, First-Order Logic, The Semantics of English Sentences, Discourse Semantics	15 Hrs [OC11, OC12, OC13, OC14, OC15]
Unit 4: Math with words (TF-IDF vectors): Bag of words, Vectorizing, Zipf's Law, Topic modeling Finding meaning in word counts (semantic analysis): From word counts to topic scores, Latent semantic analysis, Singular value decomposition, Principal component analysis, Latent Dirichlet allocation (LDA), Distance and similarity, Steering with feedback, Topic vector power Information extraction (named entity extraction and question answering) : Named entities and relations, Regular patterns, Information worth extracting, Extracting relationships (relations), In the real world	15 Hrs [OC16, OC17, OC18, OC19, OC20]

References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Natural Language Processing With Python	Steven Bird, Edward Loper	O'Reilly Media	2nd	2016
2.	Applied Text Analysis with Python	Benjamin Bengfort, Rebecca Bilbro, and Tony Ojeda	O'Reilly	1 st	2018
3.	Natural Language Processing in Action Understanding, analyzing, and generating text with Python	Hobson Lane, Cole Howard, Hannes Max Hapke	Manning Publications		2019
1.	Speech and Language Processing	Martin, J. H., & Jurafsky, D.	Pearson Education, India	2nd	2013
1.	Foundations of Statistical Natural Language Processing	Manning, Christopher and Heinrich, Schutze	MIT Press	1 st	1997

Course Outcomes (OCs)

Upon completing this course, the learner will gain the following:

- OC 1. A solid understanding of natural language versus programming language, and its practical applications.
- OC 2. Essential skills in language processing with Python, and the ability to perform simple statistics and automatic natural language understanding.
- OC 3. The ability to access text corpora and lexical resources, such as WordNet and Conditional Frequency Distributions and reuse code.
- OC 4. A deep understanding of text processing techniques, including accessing raw text from the web or disk, text normalization, segmentation, formatting, and tokenizing.
- OC 5. The knowledge and skills to format text from Lists to Strings, which can be used for further manipulation and analysis in data analysis and machine learning.
- OC 6. The ability to categorize and tag words accurately using a tagger, understand the importance of tagged corpora, map words to properties using Python dictionaries, and perform automatic tagging techniques such as N-gram and transformation-based.
- OC 7. The knowledge of how to determine the category of a word accurately; which is useful in developing natural language models.
- OC 8. The skills in learning to classify text through supervised classification, including further examples of it, evaluation, decision trees, naive Bayes classifiers, maximum entropy classifiers, and modelling linguistic patterns.
- OC 9. The skills and knowledge to extract information from text, including chunking, developing and evaluating chunkers, recursion in linguistic structure, named entity recognition, and relation extraction techniques.
- OC 10. The ability to understand the application of the above techniques in real-world natural language processing applications like chatbots, language translation, and text classification.
- OC 11. The ability to analyze sentence structure in natural language using techniques like context-free grammar, parsing with context-free grammar, and dependency grammar, which can be useful in identifying grammatical dilemmas and making sense of complex sentences.
- OC 12. A deep understanding of the importance of syntax in natural language processing, including the role of context-free grammar and how it can be used to build grammars that parse sentences automatically.
- OC 13. The ability to build feature-based grammars, including understanding grammatical features, processing feature structures, and extending feature-based grammars, which can be used to develop more sophisticated natural language processing models.

- OC 14. The skills to analyze the meaning of sentences, including natural language understanding, propositional logic, first-order logic, semantics of English sentences, and discourse semantics, which can be useful in tasks like language translation and text classification.
- OC 15. Hands-on experience with applying the various techniques taught in the course to real-world natural language processing applications, which can provide the learner with practical skills and knowledge of natural language processing concepts.
- OC 16. The ability to understand the basics of the bag of words model, vectorizing techniques, and Zipf's law, which can be used in identifying frequently used words and their relevance in a particular context.
- OC 17. An understanding of topic modeling techniques, including how to extract meaning from text using the Term Frequency-Inverse Document Frequency (TF-IDF) vector method, which can be used in tasks like document classification and topic analysis.
- OC 18. The ability to perform semantic analysis on text, including converting word counts to topic scores, using techniques like Latent Semantic Analysis (LSA), Singular Value Decomposition (SVD), Principal Component Analysis (PCA), and Latent Dirichlet Allocation (LDA).
- OC 19. The knowledge of how to extract essential information from text, including named entities and relations, using regular patterns and identifying information worth extracting. Techniques like extracting relationships (relations) can also be used in real-world natural language processing applications.
- OC 20. The ability to apply the techniques learned in the course to practical real-world natural language processing applications, including question answering, steering with feedback, and developing topic vector power.

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: 612 [Mandatory] Total Credits: 02 (60 Practical Hrs) University assessment: 25 marks	Course Name: Natural Language Processing (Practical) Total Marks: 50 marks College/Department assessment: 25 marks
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Pre requisite:

1. Sound knowledge of Python
2. Sound knowledge of concepts in probability, statistics & mathematics
3. Sound Knowledge of Artificial Intelligence

Course Objectives (COs)

- CO 1. To install NLTK and use it to convert text to speech and audio files to text.
- CO 2. To gain an understanding of various corpora and their methods and apply them to create and use own corpora, study conditional frequency distributions, tagged corpora and write programs to find most frequent noun tags.
- CO 3. To explore Wordnet dictionary and its methods and apply them in writing programs to find synonyms, antonyms, and comparing two nouns.
- CO 4. To learn and apply tokenization methods using Python's split() function, regular expressions, NLTK, spaCy library, Keras, and Gensim.
- CO 5. To identify the important NLP libraries for Indian languages and perform word tokenization, generating similar sentences, and identify the Indian language of the text.
- CO 6. To illustrate part of speech tagging and chunking, and named entity recognition using user-defined text and with NLTK corpus-treebank.
- CO 7. To define grammar using NLTK and analyze a sentence using the same, accept input strings with regular expressions, and implement deductive chart parsing using context-free grammar and a given sentence.
- CO 8. To study different stemmers like PorterStemmer, LancasterStemmer, RegexpStemmer, SnowballStemmer, and WordNetLemmatizer.
- CO 9. To implement Naive Bayes classifier, study speech tagging using spacy and NLTK, and statistical parsing with the usage of Give and Gave in Penn Treebank sample and probabilistic parser Malt parsing.
- CO 10. To study multiword expressions and normalized web distance and word similarity, and Word sense disambiguation.

List of Practical:

	Unit 1	15 hrs
1.	a. Install NLTK b. Convert the given text to speech c. Convert audio file Speech to Text.	[OC1]

2.	a. Study of various Corpus – Brown, Inaugural, Reuters, udhr with various methods like fields, raw, words, sents, categories, b. Create and use your own corpora(plaintext, categorical) c. Study Conditional frequency distributions Study of tagged corpora with methods like tagged_sents, tagged_words. d. Write a program to find the most frequent noun tags. e. Map Words to Properties Using Python Dictionaries f. Study DefaultTagger, Regular expression tagger, UnigramTagger g. Find different words from a given plain text without any space by comparing this text with a given corpus of words. Also find the score of words.	[OC2]
3.	a. Study of Wordnet Dictionary with methods as synsets, definitions, examples, antonyms. b. Study lemmas, hyponyms, hypernyms, entailments, c. Write a program using python to find synonym and antonym of word "active" using Wordnet d. Compare two nouns e. Handling stopword. f. Using nltk Adding or Removing Stop Words in NLTK's Default Stop Word List Using Gensim Adding and Removing Stop Words in Default Gensim Stop Words List g. Using Spacy Adding and Removing Stop Words in Default Spacy Stop Words List	[OC3]
4.	Text Tokenization a. Tokenization using Python's split() function b. Tokenization using Regular Expressions (RegEx) c. Tokenization using NLTK d. Tokenization using the spaCy library e. Tokenization using Keras f. Tokenization using Gensim	[OC]
5.	Important NLP Libraries for Indian Languages and perform: a. word tokenization in Hindi b. Generate similar sentences from a given Hindi text input c. Identify the Indian language of a text	[OC5]
	Unit 2	15 hrs
6.	Illustrate part of speech tagging. a. Part of speech Tagging and chunking of user defined text. b. Named Entity recognition of user defined text. c. Named Entity recognition with diagram using NLTK corpus – treebank	[OC6]
7.	a. Define grammar using nltk. Analyze a sentence using the same. b. Accept the input string with Regular expression of FA: 101+ c. Accept the input string with Regular expression of FA: (a+b)*bba d. Implementation of Deductive Chart Parsing using context free grammar and a given sentence.	[OC7]
8.	Study PorterStemmer, LancasterStemmer, RegexpStemmer, SnowballStemmer Study WordNetLemmatizer	[OC8]

9.	a. Implement Naive Bayes classifier b. Speech Tagging: i. Speech tagging using spacy ii. Speech tagging using c. nltk Statistical parsing: i. Usage of Give and Gave in the Penn Treebank sample ii. Probabilistic	[OC9]
10.	a. parser Malt parsing: i. Parse a sentence and draw a tree using malt parsing. b. Multiword Expressions in NLP c. Normalized Web Distance and Word Similarity d. Word Sense Disambiguation	[OC10]

References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
6.	Natural Language Processing With Python	Steven Bird, Edward Loper	O'Reilly Media	2 nd	2016
5.	Applied Text Analysis with Python	Benjamin Bengfort, Rebecca Bilbro, and Tony Ojeda	O'Reilly	1 st	2018
6.	Natural Language Processing in Action Understanding, analyzing, and generating text with Python	Hobson Lane, Cole Howard, Hannes Max Hapke	Manning Publications		2019
4.	Speech and Language Processing	Martin, J. H., & Jurafsky, D.	Pearson Education, India	2 nd	2013
2.	Foundations of Statistical Natural Language Processing	Manning, Christopher and Heinrich, Schutze	MIT Press	1 st	1997

Course Outcomes (OCs)

Upon completing this course, the learner will:

- OC 1. Develop the skills to install NLTK and use it to convert text to speech and audio files to text using Python language.
- OC 2. Understand different types of corpora and learn how to create own corpora, study conditional frequency distributions, and write programs to find the most frequent noun tags.
- OC 3. Explore WordNet dictionary and its methods to be able to write programs to find synonyms, antonyms, compare two nouns, and understand the relationships between words.
- OC 4. Gain proficiency in different tokenization methods and learn how to apply them using Python's split() function, regular expressions, NLTK, spaCy library, Keras, and Gensim.
- OC 5. Develop the ability to identify the important NLP libraries for Indian languages and learn how to perform word tokenization, generating similar sentences, and recognize the Indian language of the text.

- OC 6. Familiarize with part of speech tagging, chunking, and named entity recognition using user-defined text and with NLTK corpus-treebank.
- OC 7. Learn how to define grammar using NLTK and learn how to analyze a sentence, accept input strings with regular expressions, and implement deductive chart parsing using context-free grammar and a given sentence.
- OC 8. Develop knowledge about different stemmers like PorterStemmer, LancasterStemmer, RegexpStemmer, SnowballStemmer, and WordNetLemmatizer, and learn how to apply these techniques in text processing.
- OC 9. Gain experience with the implementation of supervised learning algorithm Naive Bayes classifier, understand how to apply speech tagging using spacy and NLTK, and statistical parsing with the usage of Giv and Giv in the Penn Treebank sample and probabilistic parser Malt parsing.
- OC 10. Understand how to study multiword expressions and normalized web distance and word similarity, and Word sense disambiguation, which are key techniques in natural language processing and be able to apply them in the different real-world applications.

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: 613 [Mandatory] Total Credits: 04 (60 Lecture Hrs) University assessment: 50 marks	Course Name: Deep Learning (Theory) Total Marks: 100 marks College/Department assessment: 50 marks
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Pre requisite:

1. Sound knowledge of Python
2. Sound knowledge of concepts of Artificial Neural Network

Course Objectives (COs)

To enable the students to:

- CO1: To define numerical computation concepts such as overflow, underflow, poor conditioning, and gradient-based optimization.
- CO2: To interpret the principles behind gradient-based learning, back-propagation, and optimization strategies for training deep models.
- CO3: To explain the architecture and components of deep feedforward networks, convolutional networks, and sequence modeling techniques.
- CO4: To utilize regularization techniques to improve the generalization performance of deep learning models.
- CO5: To compare and contrast various deep generative models in terms of their architecture and training procedures.

MODULE I: Fundamentals of Deep Learning	(2 CREDITS)
Unit 1: Deep Learning Basics Numerical Computation: Overflow and Underflow, Poor Conditioning, Gradient-Based Optimization, Constrained Optimization, Example: Linear Least Squares Deep Feedforward Network: Example: Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms Regularization for Deep Learning: Parameter Norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under-Constrained Problems, Dataset Augmentation, Noise Robustness, Semi-Supervised Learning, Multi-Task Learning, Early Stopping, Parameter Tying and Parameter Sharing, Sparse Representations, Bagging and Other Ensemble Methods, Dropout, Adversarial Training, Tangent Distance, Tangent Prop, and Manifold Tangent Classifier	15 Hrs [OC1, OC2, OC3]
Unit 2: Deep Networks Optimization for Training Deep Models: How Learning Differs from Pure Optimization, Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies, Algorithms with Adaptive Learning Rates, Approximate Second-Order Methods, Optimization Strategies and Meta-Algorithms Convolutional Networks: The Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features, The Neuroscientific Basis for Convolutional Networks Sequence Modelling: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Echo State Networks, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs, Optimization for Long-Term Dependencies, Explicit Memory	15 Hrs [OC4, OC5]
MODULE II : Deep Learning Research	(2 CREDITS)
Unit 3: Linear Factor Models & Autoencoder Applications: Large-Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processing, Other Applications Linear Factor Models: Probabilistic PCA and Factor Analysis, Independent Component Analysis (ICA), Slow Feature Analysis, Sparse Coding, Manifold Interpretation of PCA Autoencoders: Undercomplete Autoencoders, Regularized Autoencoders,	15 Hrs [OC6]

Representational Power, Layer Size and Depth, Stochastic Encoders and Decoders, Denoising Autoencoders, Learning Manifolds with Autoencoders, Contractive Autoencoders, Predictive Sparse Decomposition, Applications of Autoencoders	
Unit 4: Representation Learning, Approximate Inference & Deep Generative Models a. Representation Learning: Greedy Layer-Wise Unsupervised Pretraining, Transfer Learning and Domain Adaptation, Semi-Supervised Disentangling of Causal Factors, Distributed Representation, Exponential Gains from Depth, Providing Clues to Discover Underlying Causes b. Approximate Inference: Inference as Optimization, Expectation Maximization, MAP Inference and Sparse Coding, Variational Inference and Learning, Learned Approximate Inference c. Deep Generative Models: Boltzmann Machines, Restricted Boltzmann Machines, Deep Belief Networks, Deep Boltzmann Machines, Boltzmann Machines for Real-Valued Data, Convolutional Boltzmann Machines, Boltzmann Machines for Structured or Sequential Outputs, Other Boltzmann Machines, Back-Propagation through Random Operations, Directed Generative Nets, Drawing Samples from Autoencoders, Generative Stochastic Networks, Other Generation Schemes, Evaluating Generative Models	15 Hrs [OC7]

References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville	An MIT Press book	First	2016
2.	Fundamentals of Deep Learning	Nikhil Buduma	O'Reilly	First	2017
3.	Deep Learning: Methods and Applications	Deng & Yu	Now Publishers	First	2013
4.	Deep Learning CookBook	Douwe Osinga	O'Reilly	First	2017

Course Outcomes (OCs)

Upon completion of this course, student will be able to:

- OC 1. Develop proficiency in implementing numerical computation techniques to address challenges such as overflow, underflow, and poor conditioning in deep learning algorithms.
- OC 2. Demonstrate mastery in designing and training deep feedforward networks, including understanding gradient-based learning, back-propagation, and optimization strategies.
- OC 3. Apply various regularization techniques effectively to improve the generalization performance of deep learning models and handle under-constrained problems.
- OC 4. Gain expertise in convolutional networks and their applications in computer vision tasks, including image classification, object detection, and segmentation.
- OC 5. Acquire proficiency in sequence modeling techniques such as recurrent neural networks and their applications in natural language processing tasks like sentiment analysis, machine translation, and text generation.
- OC 6. Understand the principles behind linear factor models and autoencoders, and their applications in representation learning, dimensionality reduction, and manifold interpretation.
- OC 7. Utilize advanced concepts in representation learning, approximate inference, and deep generative models to tackle complex problems in unsupervised learning, generative modeling, and data synthesis.

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code:614 [Mandatory]
Total Credits: 02 (60 Lecture Hrs)
University assessment: 25 marks

Course Name: Deep Learning Practical
Total Marks: 50 marks
College/Department assessment: 25 marks

Prerequisite:

1. Sound knowledge of Python
2. Sound knowledge of concepts of Artificial Neural Network

Course Objectives(COs):

To enable the students to:

- CO1. Implement numerical computation techniques and apply them to optimize deep learning models effectively.
- CO2. Understanding the principle and practical application of gradient-based optimization.
- CO3. Implement constrained optimization algorithms.
- CO4. Build deep feedforward networks and master the architecture design and training process.
- CO5. Build and train neural networks for various tasks.
- CO6. Implement L1 and L2 norm penalties for regularization, and assess their impact on model performance.
- CO7. Improve the generalization of deep learning models with the semi-supervised learning techniques.
- CO8. Implement basic and advanced optimization algorithms & understand their role in training deep models.
- CO9. Learn advanced topics like convolution network, sequence modelling.

Prac No	Practical Description	2 CREDITS (60 hrs)
1.	Numerical Computation	4
a.	Implement numerical computation techniques in Python, focusing on handling overflow and underflow.	[OC1]
b.	Implement gradient-based optimization algorithms like gradient descent and stochastic gradient descent.	[OC1]
c.	Implement constrained optimization algorithms and apply them to example problems like linear least squares.	[OC1]
2.	Deep Feedforward Network	4
a.	Implement a deep feedforward network in a framework like TensorFlow or PyTorch.	[OC2]
b.	Solve the XOR problem using a deep feedforward network and implement gradient-based learning.	[OC2]
3.	Regularization for Deep Learning	5
a.	Implement L1 and L2 norm penalties for regularization.	[OC1, OC6]
b.	Implement dropout regularization and evaluate its effectiveness	[OC1, OC6]
c.	Explore semi-supervised learning techniques and implement early stopping.	[OC1, OC6]
d.	Explore techniques for dataset augmentation and noise robustness.	[OC1, OC6]
4.	Optimization for Training Deep Models	5
a.	Implement basic optimization algorithms like gradient descent and momentum.	[OC3]
b.	Implement optimization strategies like stochastic gradient descent with mini-batch updates.	[OC3]
5.	Convolutional Networks	5
a.	Implement convolutional neural networks (CNNs) for image classification tasks.	[OC2]
b.	Implement pooling layers and experiment with different pooling strategies.	[OC2]
6.	Sequence Modelling	5
a.	Implement recurrent neural networks (RNNs) and LSTM networks for sequence prediction tasks.	[OC2]
b.	Implement encoder-decoder architectures for sequence-to-sequence tasks like machine translation.	[OC2]
c.	Experiment with bidirectional RNNs and attention mechanisms.	[OC2]

7.	Applications	5
a.	Implement deep learning models for computer vision tasks like image classification and object detection.	[OC4]
b.	Explore applications in speech recognition and natural language processing.	[OC4]
8.	Linear Factor Models	5
a.	Implement probabilistic PCA and factor analysis algorithms.	[OC7]
b.	Experiment with independent component analysis (ICA) for blind source separation.	[OC7]
9.	Autoencoder	5
a.	Implement autoencoders and explore their applications in data compression and denoising.	[OC7]
10.	Representation Learning	5
a.	Implement unsupervised pretraining techniques like restricted Boltzmann machines (RBMs).	[OC5]
b.	Experiment with transfer learning and fine-tuning pretrained models for new tasks.	[OC5]
c.	Implement deep generative models like deep belief networks (DBNs) for unsupervised learning tasks.	[OC5]
11.	Approximate Inference:	6
a.	Implement expectation-maximization (EM) algorithm for clustering tasks.	[OC7]
b.	Explore variational inference techniques for approximate posterior estimation in Bayesian models.	[OC7]
12.	Deep Generative Models	6
a.	Implement Boltzmann machines and explore their applications in modeling complex data distributions.	[OC2]
b.	Experiment with generative adversarial networks (GANs) for image generation tasks.	[OC2]
c.	Implement autoencoder-based generative models like variational autoencoders (VAEs).	[OC2]

References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville	An MIT Press book	First	2016
2.	Fundamentals of Deep Learning	Nikhil Buduma	O'Reilly	First	201
3.	Deep Learning: Methods and Applications	Deng & Yu	Now Publishers	First	2013
4.	Deep Learning CookBook	Douwe Osinga	O'Reilly	First	2017

Course Outcomes (OCs)

Upon completing this course, the student will be able to:

OC 1.	Demonstrate a comprehensive understanding of fundamental concepts in deep learning, including numerical computation, gradient-based optimization, and regularization techniques.
OC 2.	Develop proficiency in designing, implementing, and training deep neural networks for various tasks, including image classification, sequence prediction, and generative modeling.
OC 3.	Master advanced optimization techniques for training deep models, improving convergence speed, and optimizing training efficiency.
OC 4.	Gain practical experience in applying deep learning techniques to solve real-world problems in domains such as computer vision, speech recognition, and natural language processing.
OC 5.	Develop proficiency in representation learning techniques, including unsupervised pretraining, transfer learning, and fine-tuning pretrained models for new tasks.
OC 6.	Explore techniques for improving the robustness and generalization of deep learning models, including regularization, dataset augmentation, and noise robustness techniques.
OC 7.	Develop critical thinking and problem-solving skills through hands-on projects and experiments, enabling them to tackle complex challenges in deep learning effectively.

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: (615a) [Elective] Total Credits: 04 (60 Lecture Hrs) University assessment: 50 marks	Course Name: Augmented Reality & Virtual Reality (Theory) Total Marks: 100 marks College/Department assessment: 50 marks
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Pre requisite: Nil**Course Objectives (COs)**

To enable the students to:

- CO1: To learn background of VR including a brief history of VR, different forms of VR and related technologies, and broad overview of some of the most important concepts
- CO2: To provide background in perception to educate VR creators on concepts and theories of how we perceive and interact with the world around us
- CO3: To make learner aware of high-level concepts for designing/building assets and how subtle design choices can influence user behavior
- CO4: To learn about art for VR and AR should be optimized for spatial displays with spatially aware input devices to interact with digital objects in true 3D
- CO5: Walkthrough of VRTK, an open source project meant to spur on cross-platform development

MODULE I:	(2 CREDITS)
Unit 1: Introduction: What Is Virtual Reality, A History of VR, An Overview of Various Realities, Immersion, Presence, and Reality Trade-Offs, The Basics: Design Guidelines, Objective and Subjective Reality, Perceptual Models and Processes, Perceptual Modalities	15 Hrs [OC1, OC2]
Unit 2: Perception of Space and Time, Perceptual Stability, Attention, and Action, Perception: Design Guidelines, Adverse Health Effects, Motion Sickness, Eye Strain, Seizures, and Aftereffects, Hardware Challenges, Latency, Measuring Sickness, Reducing Adverse Effects, Adverse Health Effects: Design Guidelines	15 Hrs [OC1, OC3]
MODULE II :	(2 CREDITS)
Unit 3: Content Creation, Concepts of Content Creation, Environmental Design, Affecting Behavior, Transitioning to VR Content Creation, Content Creation: Design Guidelines, Interaction, Human-Centered Interaction, VR Interaction Concepts, Input Devices, Interaction Patterns and Techniques, Interaction: Design Guidelines	15 Hrs [OC4, OC5]
Unit 4: Virtual Reality Toolkit: Open Source Framework for the Community, Data and Machine Learning Visualization Design and Development in Spatial Computing, Character AI and Behaviors, The Virtual and Augmented Reality Health Technology Ecosystem	15 Hrs [OC1,OC6]

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	The VR Book, Human Centered Design for Virtual Reality	Jason Jerald	ACM Books	1st	2016
2.	Creating Augmented and Virtual Realities	Erin Pangilinan, Steve Lukas, Vasanth Mohan	O'Reilly	1st	2019
3.	Virtual reality with VRTK4	Rakesh Baruah	APress	1st	2020

Course Outcomes(OCs)

1. Understand the basic concepts of Virtual, Augmented & Mixed Reality.
2. Understand the concepts involved in making a VR system
3. Understand the impact that VR systems would have on users
4. Understand the concepts in implement VR systems
5. Use tools to create simple VR applications

6. Understand the different tools available for creating VR applications

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: (615b) [Elective] Total Credits: 04 (60 Lecture Hrs) University assessment: 50 marks	Course Name: Digital Image Forensics (Theory) Total Marks: 100 marks College/Department assessment: 50 marks
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Prerequisites:

1. Fundamental knowledge of Digital Image Processing

Course Objectives:

- ☐ To understand describe the origin of computer forensics and the relationship between law enforcement and industry.
- ☐ Describe electronic evidence and the computing investigation process.
- ☐ Extracting Digital Evidence from Images and establishing them in court of Law.
- ☐ Enhancing images for investigation and various techniques to enhance images.
- ☐ Interpret and present Evidences in Court of Law.

Details	Lectures/Outcomes
Module I	
Unit I a) History of Forensic Digital Enhancement b) Establishing Integrity of Digital Images for Court	15 [OC1]
Unit II a) Color Modes and Channel Blending to Extract Detail b) Multiple Image Techniques	15 [OC2]
Module II	
Unit III a) Fast Fourier Transform: Background Pattern Removal b) Contrast Adjustment Techniques	15 [OC3, OC4]
Unit IV a) The Approach: Developing Enhancement Strategies for Images Intended for Analysis b) Digital Imaging in the Courts, Interpreting and Presenting Evidence	15 [OC4, OC5]

References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Forensic Digital Image Processing: Optimization of Impression Evidence	Brian Dalrymple, Jill Smith	CRC Press		2018
2.	Forensic Uses of Digital Imaging	John C. Russ, Jens Rindel, P. Lord	Taylor & Francis Group	2 nd	2016

Course Outcomes(OCs):

On completion of this course, students will be able to:

OC1 Relate computer forensics and its relationship between law enforcement and industry.

OC2 Prepare electronic evidence and the computing investigation process.

OC3 Extract Digital Evidence from Images and establishing them in court of Law.

OC4 Enhance the images for investigation.

Make it available with the report that interprets and presents Evidences in Court of Law.

Programme Name: M.Sc. (IT-Artificial Intelligence)

Course Code: (615c) [Elective] Total Credits: 04 (60 Lecture Hrs) University assessment: 50 marks	Course Name: Edge Computing (Theory) Total Marks: 100 marks College/Department assessment: 50 marks
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Pre requisite:

1. Sound Knowledge of Cloud Computing, Distributed Computing and Parallel Computing
2. Sound Knowledge of Cryptographic techniques.
3. Fundamental concept of Blockchain, IOT and Artificial Intelligence Techniques

Course Objectives (COs)

To enable the students to:

CO1: Gain a comprehensive understanding of computing paradigms, including edge computing and its essentials.

CO2: Learn about edge analytics and its applications in various domains.

CO3: Understand edge data storage security and blockchain integration with edge computing systems.

CO4: Explore real-world use cases and case studies of edge computing.

CO5: Master machine learning techniques for data science applications at the edge.

CO6: Develop insights into security considerations and future trends in edge computing

MODULE I:	(2 CREDITS)
Unit 1: 4. Computing Paradigms : Introduction to Computing , The Major Impacts of Computing Parallel Computing , Shared Memory Systems , Distributed Memory Systems , Hybrid Model , Distributed Computing ,Cluster Computing High-Performance Clusters , Load Balancing Clusters High-Availability Clusters , Utility Computing , Grid Computing , Cloud Computing , Characteristics of Cloud Environments , Cloud Models , Cloud Services Models , Cloud Deployment Models , Other Computing Paradigms , Ubiquitous Computing ,Jungle Computing , Fog Computing , Osmotic Computing , Research Directions 5. Edge Computing and Its Essentials: Introduction: Edge Computing Architecture-Edge Devices, Edge Server Cluster, Cloud Server, Background Essentials: IoT Devices - Mobile Phone-Based Sensors, Medical Sensors, Neural Sensors, Environmental and Chemical Sensors, Radio Frequency Identification, Actuators, Networking Architecture, Network Management and Control- Orchestration, Edge Computing State-of-the-Art Interfaces and Devices. Middleware- Hydra, Aura, TinyDB, FiWare, Application Interfaces. Edge Computing Simulators - PureEdgeSim, IoTSim Edge, iFogSim , EdgeCloudSim , Research Directions 6. Edge Analytics: Types of Data, Data Analytics, Goals of Data Analytics, Domains Benefiting from Big Data Analytics, Real-Time Applications of Data Analytics, Phases of Data Analytics- Data Collection and Pre-Processing, Machine Learning-Model Building, Performance Evaluation, Types of Data Analytics- Descriptive Analytics, Diagnostic Analytics, Predictive Analytics, Prescriptive Analytics. Edge Data Analytics, Potential of Edge Analytics Architecture of Edge Analytics, Machine Learning for Edge Devices. Edge Analytics: Case Study, Research Challenges and Future Research Directions	15 Hrs [OC1, OC2, OC3]
Unit 2: a. Edge Data Storage Security: Data Security, Data Confidentiality- Identity-Based Encryption Attribute-Based Encryption, Proxy Re-encryption, Functional Encryption, Honey Encryption, Searchable Encryption. Homomorphic Encryption -Types of Homomorphic Encryption Basic Functions of Homomorphic Encryption. Authentication, Single-Domain Authentication, Cross-Domain Authentication, Handover Authentication, Privacy-Preserving Schemes, Data Privacy, Location Privacy, Identity Privacy, Edge-Based Attack Detection and Prevention, Conclusions and Future	15 Hrs [OC4, OC5, OC6]

Research Directions b. Block chain and Edge Computing Systems: History of Blockchain, Distributed Ledger Technology, Role of P2P Architecture in Blockchain , Blockchain Cryptography , Characteristics of Blockchain , Benefits and Limitations of Blockchain , Types of Blockchain, Blockchain Architecture and Fundamentals , Blockchain behind Bitcoin Network , Transaction Validation , Mining and Block Structure , Consensus Mechanisms , Smart Contracts Blockchain Platforms. , Ethereum Hyperledger ,Polkadot Network ,Edge Computing with Blockchain ,Internet of Things and Blockchain ,System Design, Case Studies , Research Challenges and Future Research Directions c. Edge Computing Use Cases and Case Studies : Use Cases Edge Computing High-Potential, Gaming ,Content Delivery , Financial Sector , Augmented Reality , Healthcare Sector , Realization of Edge Computing in Healthcare Ensuring, Storage Security - Devices and Setup Case Study I: Pulse Oximeter to Detect ARD in Edge Serve , Pulse Oximetry ,Oxygen Delivery (DO2 Oxygen Consumption (VO2) , Acute Respiratory Distress Syndrome , Analysis in Edge Server , Case Study II: Blood Pressure Monitor to Predict Hypotension in Edge Server Mean Arterial Pressure , Edge Server Analysis on MAP , Case Study III: Body Composition Scale to Detect Heat Index in Edge Server Heat Index , Heat Index Analysis in Edge Server Use Case - Edge Computing/Analytics in Industrial , IOT , Conclusions and Open Research Challenges	
MODULE II :	(2 CREDITS)
Unit 3: a. Edge Computing Use Case Examples: Problems Resolved by Edge Computing, Use Case: IOT Gateway, Use Case: Smart City Surveillance, Use Case: Vehicle Telematics, Use Case: Video Streaming Services. Edge systems componentry: Hardware Architecture, Different Classes of Edge, Everything Connected Through Embedded Systems. Communication Hardware - SCADA, Networking Topologies, Personal Area Networks, Local Area Networks, Wide Area Networks b. Software and system frameworks: Typical Edge Functions and Services - Security and Hardening Remote Management and Monitoring, Interconnectivity and Networking, Software Provisioning and Upgradability, Reliability and Robustness, Operating System. Software Architecture. Frameworks - EdgeX Foundry, Microsoft Azure IOT Edge. Digital Twins, The Fog and The Mist, System Architecture – One Architecture to Rule Them All, Probably Not. Connecting things (networking and communications): A Typical Edge System in Your Home, Communication Systems Differences, Radio Spectrum Near Range Communication (PAN)- Bluetooth, NFC and RFI, Meshes (Zigbee PAN). Near Range Communication Use Cases. Long Range Communication- 5G and Cellular LoRaWAN, Satellite Communication c. Edge protocols: The language of Edge machines: Network Layering and the Basics of the OSI Model, Diving Deep into TCP/IP Networking], Industrial IOT Communications, The Language of Factory Machines, Message-Orientated, Stream-Orientated, and RESTful Protocols, The Most Prevalent Edge Communication Standard: MQTT, Alternative protocols: CoAP and AMPQ, Protocol Comparison	15 Hrs [OC6, OC7, OC8]
Unit 4: Machine Learning for Data Science d. Making the Edge work through AI: The Purpose for Clouds with Edge Computing, Work on the Cloud and the Edge, Edge Workloads - Edge Patterns. Example Workload Organization - Situational Awareness Applications, Machine Learning for the Edge, Rules and Decision Systems, Time-Series Analysis, Proportional Integral Derivative Controllers, Probabilistic Analysis System, Deep Learning Models, Federated Machine Learning, Training in the Cloud, Inference at the Edge, Proper Use of Machine Learning e. Security at the Edge: Types of Security Vulnerabilities, The Most Pervasive Internet Hack: Mirai - Mirai, Grand Theft Auto, Credit Card Fraud: Through the HVAC Supplier, Security Architecture, Hardware Security, Software Security, Communications and Network Security, Physical Security, Final Thoughts on Security f. Edge computing futures and predictions: Capitalizing on Edge Computing, Regulations and Standards for IOT and Edge Computing, Future of Edge Computing- Pervasive Edge Computing, Smart Concrete, AR/VR, Immersive Interactions and Synthetic Sensing, Devices that Understand You, Industrial and Systems Control,	15 Hrs [OC9, OC10 OC11]

References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
7.	EDGE COMPUTING Fundamentals, Advances and Applications	K. Anitha Kumari G. Sudha Sadasivam D. Dharani M. Niranjanamurth	CRC Press	First	2022
6.	MEAP Edition Manning Early Access Program Edge Computing A friendly introduction Version 3	Perry Lea	Manning Publications	Version 3	2023
1.	Fog and Edge Computing Principles and Paradigms	Rajkumar Buyya and Satish Narayana Srirama	John Wiley & Sons, Inc	first	2019
2.	Edge Computing: A Primer	Jie Cao Quan Zhang Weisong Shi	Springer		2018

Course Outcomes(OCs)

Upon completion of this course:

OC1: Comprehensive Understanding of Computing Paradigms: Students will gain a deep understanding of various computing paradigms, including parallel computing, distributed systems, cloud computing, and emerging paradigms like edge, fog, and osmotic computing.

OC2: Proficiency in Edge Computing Essentials: Students will become proficient in the fundamentals of edge computing, including its architecture, devices, networking, and middleware. They will also learn about state-of-the-art interfaces, simulators, and future directions in edge computing research.

OC3: Expertise in Edge Analytics: Through studying edge analytics, students will learn about different types of data, data analytics goals, and real-time applications. They will gain hands-on experience in data collection, preprocessing, machine learning model building, and performance evaluation for edge devices.

OC4: Knowledge of Edge Data Storage Security: Students will understand various aspects of data security in edge computing, including encryption techniques, authentication mechanisms, privacy-preserving schemes, and edge-based attack detection and prevention methods.

OC5: Understanding of Blockchain Integration with Edge Computing: Students will explore the history, architecture, and fundamentals of blockchain technology, as well as its integration with edge computing systems. They will learn about blockchain platforms, use cases, and research challenges in the context of edge computing.

OC6: Ability to Apply Edge Computing in Real-World Scenarios: Students will analyze and discuss various use cases and case studies where edge computing demonstrates high potential, such as gaming, content delivery, financial sectors, augmented reality, and healthcare. They will gain insights into realizing edge computing in healthcare and ensuring storage security in edge devices.

OC7: Understanding the framework of IOT applications, fog computing and communication protocol: Students completing the software and system frameworks section will understand edge functions, security, networking, and software provisioning. They'll master remote management, familiarize with EdgeX Foundry and Azure IoT Edge, and grasp concepts like digital twins and fog computing. They'll also learn about communication protocols from Bluetooth to 5G

OC8: Familiarity with Edge Systems Componentry and Protocols: Students will become familiar with the hardware architecture, communication hardware, and different classes of edge systems. They will also learn about edge protocols, networking topologies, and communication standards for edge devices.

OC9: Proficiency in Machine Learning for Data Science at the Edge: Through studying machine learning for data science at the edge, students will gain expertise in various machine learning techniques applicable to edge devices, including time-series analysis, deep learning models, federated machine learning, and proper use of machine learning for inference at the edge.

OC10: Awareness of Security Considerations at the Edge: Students will understand different types of security vulnerabilities and security architectures relevant to edge computing. They will learn about hardware security, software security, communication security, and physical security measures to mitigate risks at the edge.

OC11: Insights into the Future of Edge Computing: Students will gain insights into the future trends and predictions in edge computing, including pervasive edge computing, smart infrastructure, immersive interactions, innovation in sensors and electronics, and democratized communication systems. They will also understand the regulatory and standardization aspects for IoT and edge computing

Evaluation Scheme

Theory courses of 4 credits: Total marks 100. Out of the total, 50 % each for internal and external evaluation.

A. Internal Evaluation (30m + 10m + 10m = 50 Marks)

The internal assessment marks shall be awarded as follows:

1. 30 marks (Any one of the following):

- a. Written Test of 30 Marks
- b. SWAYAM (Advanced Course) of minimum 20 hours and certification exam completed or
- c. NPTEL (Advanced Course) of minimum 20 hours and certification exam completed or
- d. Valid International Certifications (Prometric, Pearson, Certiport, Coursera, Udemy and the like)
- e. Certification marks of one completed exam shall be awarded to one course only. For four courses, the students will have to complete four certifications.

(Note: Only those certification/courses suggested by the department shall be deemed valid, Student cannot do any certification on their own)

2. 10 marks

10 marks from every course (Two 4 credits mandatory courses, one 2 credits mandatory course, one 4 credits elective course) coming to a total of 40 marks, shall be awarded on publishing of research paper in UGC approved / Other Journal with plagiarism less than 15%. The marks can be awarded as per the impact factor of the journal, quality of the paper, importance of the contents published, social value.

3. 10 marks

Open Book examination based on problem solving related to the respective subject.

i. Suggested format of Question paper of 30 marks for the written test.

Q1.	Attempt <u>any two</u> of the following:	16 marks
a.		
b.		
c.		
d.		
Q2.	Attempt <u>any two</u> of the following:	14 marks
a.		
b.		
c.		
d.		

B. External Examination: (50 marks) Duration : 2 hrs

	All questions are compulsory	
Q1	(Based on all units) Attempt <u>any two</u> of the following:	10 marks
a.	Unit 1	
b.	Unit 2	
c.	Unit 3	
d.	Unit 4	
Q2	(Based on Unit 1) Attempt <u>any two</u> of the following:	10 marks
Q3	(Based on Unit 2) Attempt <u>any two</u> of the following:	10 marks
Q4	(Based on Unit 3) Attempt <u>any two</u> of the following:	10 marks
Q5	(Based on Unit 4) Attempt <u>any two</u> of the following:	10 marks

Theory courses of 2 credits: Total marks 50. Out of the total, 50 % each for internal and external evaluation.

A. Internal Evaluation (25 Marks)

The internal assessment marks shall be awarded as follows:

1. 10 marks from every course (Two 4 credits mandatory courses, One 2 credits mandatory course, One 4 credits elective course) coming to a total of 40 marks, shall be awarded on publishing of research paper in UGC approved / Other Journal with plagiarism less than 15%. The marks can be awarded as per the impact factor of the journal, quality of the paper, importance of the contents published, social value.
2. 10 marks - Open Book examination based on problem solving related to the respective subject.
3. 5 marks - Assignment/Group discussion.

B. External Examination: (25 marks) Duration : 1 hr

	All questions are compulsory	
Q1	(Based on Unit 1) Attempt <u>any two</u> of the following:	13 marks
Q2	(Based on Unit 2) Attempt <u>any two</u> of the following:	12 marks

Practical courses of 2 credits: Total marks 50. Out of the total, 50 % each for internal and external evaluation.

A. Practical Evaluation Internal (25 marks)

1.	Performance during all practical sessions	10
2.	Problem solving with the acquired programming skills	10
3.	Viva Voce	5

B. Practical Evaluation External (25 marks)

A Certified copy of hard-bound journal is essential to appear for the practical examination.

1.	Practical Question	15
2.	Journal	5
3.	Viva Voce	5

Sign of Chairperson
Dr. Mrs. R.
Srivaramangai
Ad-hoc BoS (IT)

Sign of the
Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science &
Technology

Sign of Offg. Dean,
Prof. Shivram S. Garje
Faculty of Science &
Technology

Appendix B**Justification for M.Sc. (IT-Artificial Intelligence)**

1.	Necessity for starting the program:	The demand for artificial intelligence (AI) skills in the job market is rapidly growing and projected to continue its upward trajectory. AI has been increasingly integrated into various industries and sectors, transforming the way businesses operate and creating new job opportunities. So it's essential to stay updated on the latest trends, technologies, and applications to remain relevant in the job market.
2.	Whether the UGC has recommended the program:	Yes
3.	Whether all the programs have commenced from the academic year 2023-24	The program has commenced from 2022-2023 academic year onwards
4.	The programs started by the University are self-financed, whether adequate number of eligible permanent faculties are available?:	Yes. Some experts are called as visiting faculties
5.	To give details regarding the duration of the program and is it possible to compress the program?:	2 years. Not possible to compress the program
6.	The intake capacity of each program and no. of admissions given in the current academic year:	40 seats. 2023-2024 admission is yet to start
7.	Opportunities of Employability / Employment available after undertaking these courses:	Artificial intelligence (AI) presents numerous opportunities and a promising landscape for employability. The continued advancement and integration of AI across various industries create a range of job prospects for individuals with AI skills and expertise. The career opportunities ranges from AI experts for healthcare, finance, production, marketing, education, CRM etc.

Sign of Chairperson
Dr. Mrs. R.
Srivaramangai
Ad-hoc BoS (IT)

Sign of the
Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science &
Technology

Sign of Offg. Dean,
Prof. Shivram S. Garje
Faculty of Science &
Technology