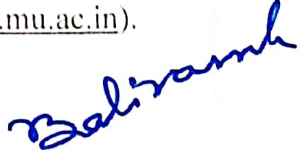# University of Mumbai

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/2024-25/4 dated 11th June, 2024 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. 6.2 (N) have been accepted by the Academic Council at its meeting held on 28th June, 2024 **vide** item No. 6.2 (N) and that in accordance therewith the **syllabus** for the **M.Sc. (Information Technology) (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).

MUMBAI – 400 032
20th August, 2024

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

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

A.C/6.2(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 direcotr@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. (Information Technology)

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. (Information Technology)**
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: SP-105A** **R: SP-105B**	**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

Preamble

1) Introduction

Master of Science (Information Technology) is a Programme designed to meet the needs of the market for expertise in Information Technology (IT). The Programme is intended to address the increasing demand in the work-place for IT professionals with a broad and sound knowledge of both technical and managerial skills. A master degree is granted to individuals who have undergone study demonstrating a mastery or high-order overview of a specific area.

2) Aims and Objectives

1. To equip postgraduate students with an integrated set of skills that will allow them to develop their professional careers in Information Technology.

2. To equip students with the theoretical and practical knowledge that is necessary to enable them to understand the design of complex computer applications/science.

3. The programme also prepares students to embrace future developments in the field and has a demonstrated professional relevance.

4. The programme helps students to acquire the latest skills and build their future capabilities using world-class technology. At the end of this programme, a student will possess a strong foundation of computer systems and information technology.

5. Dexterity in advanced programming languages; power to build sophisticated software for wide area of applications.

6. Skills to work with higher end applications in internet technologies; also managerial ability to analyze, design, develop and to maintain software development.

3) Learning Outcomes

1. Apply the knowledge of mathematics, science and computing in the core information technologies.

2. Identify, design, and analyze complex computer systems and implement and interpret the results from those systems.

3. Design, implement and evaluate a computer-based system, or process component, to meet the desired needs within the realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

4. Review literature and indulge in research using research based knowledge and methods to design new experiments, analyze, and interpret data to draw valid conclusions.

5. Select and apply current techniques, skills, and tools necessary for computing practice and integrate IT-based solutions into the user environment effectively.

6. Apply contextual knowledge to assess professional, legal, health, social and cultural issues during profession practice.

7. Analyze the local and global impact of computing on individuals, organizations, and society.

8. Apply ethical principles and responsibilities during professional practice.

9. Function effectively as a team member or a leader to accomplish a common goal in a multidisciplinary team.

10. Communicate effectively with a range of audiences using a range of modalities including written, oral and graphical.

11. Apply the knowledge of engineering and management principles to manage projects effectively in diverse environments as a member or a leader in the team.

12. Engage in independent and life-long learning for continued professional development

4) Credit Structure of the Program (Sem I, II, III, & IV)
5)

Credit Distribution Structure for Two Years/ One Year PG

R: SP-105A

Year	Level	Sem	Major				RM	OJT/FP	RP	Cum. Cr.	Degree
			Mandatory			Electives					
1	6.0	Sem I	2*4+2*2 + 2			4	4	-	-	22	PG Diploma (after 3 Years Degree)
			Data Science(501)	TH	4	Security Breaches and Countermeasures (506a) (PR) **(OR)** Data Center Technologies (506b) **(OR)** Image Processing (506c)	Research Methodology(510)				
			Data Science Practical(502)	PR	2						
			Soft Computing Techniques(503)	TH	4						
			Soft Computing Techniques Practical(504)	PR	2						
			Cloud Computing(505)	TH	2						
		Sem II	2*4+2*2 + 2			4	-	(517)4	-	22	
			Big Data Analytics (511)	TH	4	Malware Analysis (PR) (516a) **(OR)** Cloud Management (PR) (516b) **(OR)** Computer Vision (PR) (516c)					
			Big Data Analytics Practical (512)	PR	2						
			Modern Networking (513)	TH	4						
			Modern Networking Practical (514)	PR	2						
			Microservices Architecture (515)	TH	2						
Cum. Cr. For PG Diploma			28			8	4	4		44	
Exit Option: PG Diploma (44 credits) after Three Year UG Degree											
(M.Sc (Information Technology)											

R: SP-105B

Year	Level	Sem (2yr)	Major				RM	OJT/FP	RP	Cum. Cr.	Degree
2	6.5	Sem III	2*4+2*2 + 2			4	-	-	(607)4	22	PG Degree after 3yr UG or PG Degree after 4yr UG
			Advanced AI (601)	TH	4	Natural Language Processing (606a) **(OR)** Security Operations Center (PR) (606b) **(OR)** Server Virtualization on VMWare Platform (PR) (606c)					
			Advanced AI Practical (602)	PR	2						
			Machine Learning (603)	TH	4						
			Machine Learning Practical (604)	PR	2						
			Storage as a Service (605)	TH	2						
		Sem IV	2*4+2 *2			4	-	-	(616)6	22	
			Blockchain (611)	TH	4	Robotic Process Automation (PR) (615a) **(OR)** Cyber Forensics (PR) (615b) **(OR)** Advanced IoT (PR) (615c)					
			Blockchain Practical (612)	PR	2						
			Deep Learning (613)	TH	4						
			Deep Learning Practical (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	

Semester III

Programme Code: ____   **Programme Name:** <u>M.Sc. (Information Technology)</u>

Course Code:601 [Mandatory] **Total Credits:** 04 (60 Lecture Hrs) **University assessment:** 50 marks	**Course Name:** Advanced Artificial Intelligence (Theory) **Total Marks:** 100 marks **College/Department assessment:** 50 marks

Course Objectives (COs)

To enable the students to:

    Course Objectives:

    - To explore the applied branches of artificial intelligence

    - To enable the learner to understand applications of artificial intelligence

    - To enable the student to solve the problem aligned with derived branches of artificial intelligence.

MODULE I: Advanced Artificial Intelligence	(2 CREDITS)
Unit 1: Foundations of Artificial Intelligence Introduction to Artificial Intelligence - Intelligent Agents - Problem-solving using search algorithms - Knowledge Representation [Ref:01] Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville	18 Hrs [OC1, OC2]
Unit 2: Advanced Artificial Intelligence - Introduction to advanced AI concepts - Deep learning and neural networks - Natural language processing and understanding - Reinforcement learning - AI applications in various domains such as healthcare, finance, and robotics [Ref:02] Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig	15 Hrs [OC3,OC4]
MODULE II :	(2 CREDITS)
Unit 3: Machine Learning - Machine Learning Paradigms: Machine Learning systems, - supervised and un-supervised learning, inductive learning, - deductive learning, clustering, support vector machines, cased - based reasoning and learning. - Artificial Neural Networks: Artificial Neural Networks, - Single-Layer feedforward networks, multi-layer feed-forward - networks, radial basis function networks, design issues of - artificial neural networks and recurrent networks [Ref:05] Artificial Intelligence", Saroj Kaushik, Cengage, 1st Edition, 2019	12 Hrs [OC5, OC6]

Unit 4 Generative AI	
- Introduction to generative AI and its applications - Generative adversarial networks (GANs) - Variational autoencoders - Text generation and image synthesis using generative AI - Ethical considerations in generative AI [Ref:04] Python Machine Learning" by Sebastian Raschka and Vahid Mirjalili	15 Hrs [OC7, OC8]

Course Outcomes (OCs)

1. 1.Understand the fundamental principles and concepts of Artificial Intelligence.
2. Implement intelligent agents for different applications.
3. Understand advanced AI concepts and techniques
4. Demonstrate proficiency in deep learning and neural networks
5. Understand the concepts and applications of generative AI
6. 6.Implement generative adversarial networks and variational autoencoders
7. 7.Develop skills in using neural networks for image recognition and text generation
8. 8.Create and train GAN models for image synthesis

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1	Deep Learning	Ian Goodfellow, Yoshua Bengio, and Aaron Courville	MIT Pres		2020
2	Artificial Intelligence: A Modern Approach	Stuart Russell and Peter Norvig	Prentice Hall		2020
3	Reinforcement Learning: An Introduction	Richard S. Sutton and Andrew G. Barto	MIT Press		2023
4	Python Machine Learning	Sebastian Raschka and Vahid Mirjalili	Packt Publication		2021
5	Artificial Intelligence	Saroj Kaushik, Cengage	Cngage Publication		2019

Programme Code:_____   **Programme Name: <u>M.Sc. (Information Technology)</u>**

Course Code:604	**Course Name:** Advanced Artificial Intelligence
Total Credits: 02 (60 Lecture Hrs.)	**Total Marks: 50 marks**
University Assessment: 25 marks	**College/Department assessment: 25 marks**

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Course Objectives (CO)

After completion of course the learner will:

CO1: be able to understand the fundamentals concepts of expert system and its applications.

CO2: be able to use probability and concept of fuzzy sets for solving AI based problems.

CO3: be able to understand the applications of Machine Learning. The learner can also apply fuzzy system for solving problems.

CO4: learner will be able to apply to understand the applications of genetic algorithms in different problems related to artificial intelligence.

CO5: A learner can use knowledge representation techniques in natural language processing

Sr.No.	Practical List	2 Credits (60Hrs)
1.	Implementing advanced deep learning algorithms such as convolutional neural networks (CNNs) or recurrent neural networks (RNNs) using Python libraries like TensorFlow or PyTorch.	OC1
2	.Building a natural language processing (NLP) model for sentiment analysis or text classification.	OC2
3	Creating a chatbot using advanced techniques like transformer models.	OC3
4	Developing a recommendation system using collaborative filtering or deep learning approaches.	OC4
5	Implementing a computer vision project, such as object detection or image segmentation.	
6	Training a generative adversarial network (GAN) for generating realistic images.	OC6
7	Applying reinforcement learning algorithms to solve complex decision-making problems.	OC7
8	Utilizing transfer learning to improve model performance on limited datasets.	Oc8
9	Building a deep learning model for time series forecasting or anomaly detection.	OC9
10	Implementing a machine learning pipeline for automated feature engineering and model selection.	OC10
11	Using advanced optimization techniques like evolutionary algorithms or	OC11

12	Deploying a machine learning model in a production environment using containerization and cloud services.	OC12
13	Use Python libraries such as GPT-2 or textgenrnn to train generative models on a corpus of text data and generate new text based on the patterns it has learned.	OC13
14	Experiment with neural networks like GANs (Generative Adversarial Networks) using Python libraries like TensorFlow or PyTorch to generate new images based on a dataset of images.	OC14

(Note: row above table beginning reads) Bayesian optimization for hyperparameter tuning.

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1	Deep Learning	Ian Goodfellow, Yoshua Bengio, and Aaron Courville	MIT Pres		2020
2	Artificial Intelligence: A Modern Approach	Stuart Russell and Peter Norvig	Prentice Hall		2020
3	Reinforcement Learning: An Introduction	Richard S. Sutton and Andrew G. Barto	MIT Press		2023
4	Python Machine Learning	Sebastian Raschka and Vahid Mirjalili	Packt Publication		2021
5	Artificial Intelligence	Saroj Kaushik, Cengage	Cngage Publication		2019

Course Outcomes (OCs)

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

1. Understand Deep Learning Fundamentals:
2. Understand NLP Fundamentals.
3. Implement Chatbot Architectures:
4. Implement Deep Learning approach
5. Understand Computer Vision
6. Understand Generative Adversarial Networks (GANs)
7. Understand reinforcement learning algorithms
8. Understand Transfer learning fundamentals
9. .Implement anomaly detection technique
10. Understand Automated techniques
11. Implement evolutionary algorithms
12. Deploying a machine learning model
13. Deploying Python Libraries
14. Understand Generative Adversarial Networks implementation

Programme Code:____ **Programme Name: <u>M.Sc. (Information Technology)</u>**

Course Code:603 Total Credits: 04 (60 Lecture Hrs.) University Assessment: 50 marks	Course Name: Machine Learning Total Marks: 100 marks College/Department assessment: 50 marks

Prerequisite:
Basic understanding of Linear Algebra, Calculus, and Python programming

Course Objectives (CO)

CO1 To define and categorize machine learning problems.

CO2 To understand the principles of machine learning and the core algorithms used in machine learning.

CO3 To analyze and implement machine learning models for real-time applications.

CO4 To evaluate and improve the performance of machine learning models.

MODULE I: Introduction to Machine Learning	(2 CREDITS)
Unit I **Introduction** What Is Machine Learning? Basic Concepts in Machine Learning - Classification versus Regression, Supervised versus Unsupervised Learning Simple versus Complex Models, Parametric versus Nonparametric Models Overfitting versus Underfitting, Bias–Variance Trade-Off **General Principles in Machine Learning** Occam's Razor, No-Free-Lunch Theorem, Law of the Smooth World, Curse of Dimensionality. **Advanced Topics in Machine Learning** Reinforcement Learning, Meta-Learning, Causal Inference, and Other Advanced topics **Mathematical Foundation** **Probability and Statistics** Random Variables and Distributions, Expectation: Mean, Variance, and Moments, Joint, Marginal, and Conditional Distributions, Common Probability Distributions, Transformation of Random Variables **Information Theory** Information and Entropy, Mutual Information, KL Divergence **Mathematical Optimization** General Formulation, Optimality Conditions, Numerical Optimization Methods	15 Hrs [OC1, OC2]
Unit II **Classification Algorithms** Introduction, Decision-based methods: Nonlinear Instance-based methods, Decision Tree algorithm, Use Cases **(Reference 2)** **Feature Extraction**	12 Hrs [OC3,OC4]

Feature Extraction: Concepts,Linear Dimension Reduction, Nonlinear Dimension Reduction (I): Manifold Learning, Nonlinear Dimension Reduction (II): Neural Networks	
MODULE II: Models in Machine Learning and Applications	**(2 CREDITS)**
Unit III **Discriminative Models** Statistical Learning Theory, Linear Models, Learning Discriminative Models in General, Neural Networks, Ensemble Learning **Generative Models** Overview of Generative Models, Formulation of Generative Models, Bayesian Decision Theory, Statistical Data Modeling, Density Estimation, Maximum-Likelihood Estimation, Maximum-Likelihood Classifier, Generative Models (in a Nutshell) Generative versus Discriminative Models **Unimodal Models** Gaussian Models, Multinomial Models, Markov Chain Models, Generalized Linear Models **Mixture Models** Formulation of Mixture Models, Expectation-Maximization Method, Expectation-Maximization Method, Gaussian Mixture Models, Hidden Markov Models **Entangled Models** Formulation of Entangled Models, Linear Gaussian Models, Non-Gaussian Models, Deep Generative Models **Bayesian Learning** Formulation of Bayesian Learning, Conjugate Priors, Approximate Inference, Gaussian Processes **Graphical Models** Concepts of Graphical Models, Bayesian Networks, Markov Random Fields	18 Hrs [OC5, OC6]
Unit IV Domain-Based Machine Learning Applications, Ethical Aspects of Machine Learning **(Reference 2)**	15 Hrs [OC7, OC8, OC9, OC10, OC11]

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1	Machine Learning Fundamentals: A Concise Introduction	Hui Jiang	Cambridge University Press	First	2021
2	Machine Learning Concepts, Techniques and Applications	T V Geetha, SSendhilkumar	CRC Press Taylor & Francis Group	First	2023
3	Mastering Classification Algorithms for Machine Learning	Partha Majumdar	BPB	First	2023
4	Machine Learning for Absolute Beginners	Oliver Theobald	Scatterplot Press	Third	2021
5	Machine Learning: The Art and Science of Algorithms that Make Sense of Data	Peter Flach	Cambridge University Press	First	2012

Online Resources	Instructor slides https://github.com/iNCML/MachineLearningBook

Course Outcomes (OCs)

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

1. Define and demonstrate an understanding of Machine Learning and its related terms conceptually and mathematically

2. Identify and differentiate the advantages and limitations of Machine Learning algorithms and their use cases.

3. Implement classifier algorithms for supervised learning tasks.

4. Apply feature engineering techniques to improve a dataset for machine learning.

5. Evaluate the performance of different machine learning models on a given dataset.

6. Diagnose reasons for poor performance in a machine learning model.

7. Analyze the ethical implications of a machine learning system.

8. Critique the suitability of a machine learning solution for a real-world problem, considering factors beyond just model performance.

9. Assess the potential biases and fairness concerns in a machine learning model.

10. Develop a custom machine learning algorithm for a specific real-world problem.

11. Propose a comprehensive machine learning solution to address a complex real-world challenge.

Programme Code:____ **Programme Name: <u>M.Sc. (Information Technology)</u>**

Course Code:604 **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:

Basic understanding of Linear Algebra, Calculus, and Python programming and libraries.

Course Objectives (CO)

CO1   To demonstrate proficiency in using Python libraries like Sci-kit-learn, NumPy, Pandas,PyTorch, Keras and Matplotlib for machine learning tasks.

CO2   To apply techniques to clean and handle missing data, outliers, and different data types (numerical, categorical)

CO3   To Select, scale, and normalize features to enhance model performance.

CO4   To evaluate and assess the performance of machine learning models like classification and regression.

CO5   To translate problem statements into machine learning solutions

Sr.No.	Practical List	2 Credits (60Hrs)
1.	**Data Pre-processing and Exploration**	OC1
a.	Load a CSV dataset. Handle missing values, inconsistent formatting, and outliers.	
b.	Load a dataset, calculate descriptive summary statistics, create visualizations using different graphs, and identify potential features and target variables **Note**: Explore Univariate and Bivariate graphs (Matplotlib) and Seaborn for visualization.	
c.	Create or Explore datasets to use all pre-processing routines like label encoding, scaling, and binarization.	
2.	**Testing Hypothesis**	OC1
a.	Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a. CSV file and generate the final specific hypothesis. (Create your dataset)	
3	**Linear Models**	OC2, OC6
a.	**Simple Linear Regression** Fit a linear regression model on a dataset. Interpret coefficients, make predictions, and evaluate performance using metrics like R-squared and MSE	
b.	**Multiple Linear Regression** Extend linear regression to multiple features. Handle feature selection and	

	potential multicollinearity.	
c.	**Regularized Linear Models** (Ridge, Lasso, ElasticNet)	
	Implement regression variants like LASSO and Ridge on any generated dataset.	
4	**Discriminative Models**	OC2,OC6
a	**Logistic Regression** Perform binary classification using logistic regression. Calculate accuracy, precision, recall, and understand the ROC curve**.**	
b.	Implement and demonstrate k-nearest Neighbor algorithm. Read the training data from a .CSV file and build the model to classify a test sample. Print both correct and wrong predictions.	
c.	Build a decision tree classifier or regressor. Control hyperparameters like tree depth to avoid overfitting. Visualize the tree.	
d.	Implement a Support Vector Machine for any relevant dataset.	
e.	Train a random forest ensemble. Experiment with the number of trees and feature sampling. Compare performance to a single decision tree.	
f.	Implement a gradient boosting machine (e.g., XGBoost). Tune hyperparameters and explore feature importance.	
5.	**Generative Models**	OC2,OC6
a.	Implement and demonstrate the working of a Naive Bayesian classifier using a sample data set. Build the model to classify a test sample.	
b.	Implement Hidden Markov Models using hmmlearn	
6.	**Probabilistic Models**	OC2,OC6
a.	Implement Bayesian Linear Regression to explore prior and posterior distribution.	
b.	Implement Gaussian Mixture Models for density estimation and unsupervised clustering	
7.	**Model Evaluation and Hyperparameter Tuning**	OC3,OC4,OC5
a.	Implement cross-validation techniques (k-fold, stratified, etc.) for robust model evaluation	
b.	Systematically explore combinations of hyperparameters to optimize model performance.(use grid and randomized search)	
8.	**Bayesian Learning**	OC3,OC4,OC5
a.	Implement Bayesian Learning using inferences	
9.	**Deep Generative Models**	OC3,OC4,OC5
a.	Set up a generator network to produce samples and a discriminator network to distinguish between real and generated data. (Use a simple small dataset)	
10.	Develop an API to deploy your model and perform predictions	OC6, OC7

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1	Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow	Aurilien Geron	O'Reilly	Third	2022
2	Python Machine Learning for Beginners		AI Publishing LLC	First	2020

Course Outcomes (OCs)

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

1. Preprocess the given dataset and perform a relevant assessment of data.
2. Implement classifier algorithms for supervised learning tasks.
3. Apply feature engineering techniques to improve a dataset for machine learning.
4. Evaluate the performance of different machine learning models on a given dataset.
5. Diagnose reasons for poor performance in a machine learning model.
6. Assess the potential biases and fairness concerns in a machine learning model.
7. Develop a custom machine learning algorithm for a specific real-world problem.

Programme Code:_____ **Programme Name: <u>M.Sc. (Information Technology</u>**

Course Code: 605 [Mandatory] **Total Credits:** 02 (30 Lecture Hrs) **University assessment:** 25 marks	**Course Name**: Storage as a Service **Total Marks:** 50 marks **College/Department assessment:** 25 marks

Pre-requisite:
- Knowledge about cloud computing, (SDLC)
- Basic knowledge of Networking
- **Course Objectives (COs):**

To enable the students to:

1. Gain a deep understanding of storage network architecture.
2. Analyze and design storage networks to meet diverse requirements.
3. Acquire comprehensive knowledge of storage technologies.
4. evaluate and select appropriate storage devices and subsystems based on performance, reliability, and scalability criteria.
5. Develop Proficiency in File System management and learn data Management. Strategies
6. Understand the storage networking fundamentals, technologies, protocols, and their best practices.

MODULE I:	(2 CREDITS)
Unit 1: a. **Data Access in the Internet Era**: Availability Requirements for Network Storage, Traditional Client/Server Computing with Direct Attached Storage, Network Storage Architectures That Overcome DAS. Limitations Establishing a Context for Understanding Storage Networks, The Three Primary Functions of Storage Networking, Connecting, Storing, Filing, File Systems, and Operating Systems, SAN and NAS as Storing and Filing Applications. Getting Down with Storage I/O: Requirements for Storage I/O, The I/O Path. b. **Storage Devices:** Disk Drives, Tape Drives. **Storage Subsystems**: Subsystem Architecture, Common Functions of Storage Subsystems JBOD Tape Subsystems and Disk Subsystems for Backup. **SCSI Storage Fundamentals and SAN Adapters:** The Architecture and Logic of SCSI. SCSI Command Basics HBAs and Network Storage Interfaces Device. **Interconnect Technologies for Storage Networks:** Fundamental Concepts in Storage Interconnects, Legacy DAS Interconnects, Serial Storage Interconnects c. **Storage Virtualization:** The Power in Volume Management , Software and SAN Virtualization Systems , The Concept of Storage Virtualization , A Review of	15 Hrs [OC1, OC2, OC3,]

Technologies Used in Storage Virtualization , Virtualization Products: Volume Managers and SAN Virtualization Systems , Performance of SAN Virtualization ,Scaling Storage with Virtualization , Address Space Manipulation Techniques , Storage Pooling , Extending Management Functions in Volume Management and SAN , Virtualization Systems , Reliability and Risk Considerations. **Network Backup:** The Foundation of Storage Management Fundamentals of Backup and Recovery, Backup Operations, Backup Applications in Storage Networks, Disk-Based Backup	

Unit 2:
 	
    a.   **File System Fundamentals:** The Strange and Wonderful Relationship Between File Systems and, Operating Systems, File System Structures, File System Constructs and Functions. **Network File Systems and Network Attached Storage:** Fundamentals of Network File Systems, The Complete I/O Process for File I/O in a Network, NFS and CIFS Protocols for Network File Systems, Applications for Network File Storage Extended Features of Network File Systems Network Attached Storage (NAS)
 	
    b.   **New Directions in Network Filing:** Clustered File Systems, Distributed File Systems, and Network Storage for Databases Cluster File Systems, Super-Scaling Network File Systems with SAN-Based Distributed File, Systems Network Storage for Databases.
 	
  Data Management: Managing Data in Time Historical Versions of Files, Storing Data in Compliance with Government Regulations Capacity Management, Tiered Storage, Information Life Cycle Management.
 	
  c. **Overview of Storage Networking**: Brief History of Storage Drivers for Change, What Is a Storage Network? Block Storage Protocol Review: ATA, SCSI, and SBCCS, Mainframe Storage Networking: ESCON and FICON, File Server Protocol Review: CIFS, NFS, and DAFS, Backup Protocols: NDMP and EXTENDED COPY, Optical Technologies: SONET/SDH, DWDM/CWDM, and RPR/802.17, Virtualization Implementations: Host, Storage Subsystem, and Network. **OSI Reference Model Versus Other Network Models**: OSI Reference Model, SCSI Bus Interface and the ANSI T10 SCSI-3 Architecture Model, Ethernet and the IEEE 802 Reference Model, TCP/IP Suite and the ARPANET Model, Fibre Channel Architecture and ANSI T11 Model **.** **Overview of Network Operating Principles:** Conceptual Underpinnings, SCSI Parallel Interface, Ethernet, TCP/IP Suite, Fibre Channel. **Overview of Modern SCSI Networking Protocols**: iSCSI, FCP, FCIP, iFCP
	15 Hrs
	
	[OC4, OC5, OC6]

References:

References:					
Sr.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**

No.					
1.	Storage Networking Fundamentals: An Introduction to Storage Devices, Subsystems, Applications, Management, and Filing Systems	Marc Farley	Cisco Press		2004
2	Storage Networking Protocol Fundamentals	James Long	Cisco Press		2006
3	Storage Virtualization: Technologies for Simplifying Data Storage and Management	Tom Clark	Addison Wesley Professional		2005
4	Information Storage and Management Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments	Somasundaram Gnanasundaram Alok Shrivastava	John Wiley & Sons, Inc.	2nd	2012

Course Outcomes (OCs):
Upon completing this course, the student will be able to:

OC1: Covers the evolution of data access methods and introduces concepts like network storage architectures, storage networking functions, and storage I/O requirements.

OC2: Discusses different types of storage devices (disk drives, tape drives) and subsystem architectures, along with storage interconnect technologies like SCSI.

OC3: Explores the concept of storage virtualization, its technologies, and implications for performance and reliability, as well as the fundamentals of network backup.

OC4: Covers the relationship between file systems and operating systems, network file system basics, and protocols like NFS and CIFS.

OC5: Discusses clustered and distributed file systems, network storage for databases, and data management techniques including historical file versions and compliance storage.

OC6: Provides a historical context for storage networking, reviews block and file storage protocols, optical technologies, virtualization implementations, and network operating principles.

Programme Code:＿＿＿   **Programme Name: <u>M.Sc. (Information Technology</u>**

Course Code: 606a **Total Credits:** 04 (60 Lecture Hrs) **University assessment:** 50 marks	**Course Name:** Natural Language Processing **Total Marks:** 100 marks **College/Department assessment:** 50 marks

Pre-requisite: Foundational understanding of Soft Computing Techniques, encompassing statistics, and a basics of grammatical concepts.

Course Objectives (COs):
> To enable the students to:

CO1: The prime objective of this course is to introduce the students to the field of Language Computing and its applications ranging from classical era to modern context.

CO2: To provide understanding of various NLP tasks and NLP abstractions such as Morphological analysis, POS tagging, concept of syntactic parsing, semantic analysis etc.

CO3: To provide knowledge of different approaches/algorithms for carrying out NLP tasks.

CO4: To highlight the concepts of Language grammar and grammar representation in Computational Linguistics.

MODULE I:	**(2 CREDITS)**

Unit I
  a) Introduction to NLP:
  Brief history, NLP applications, Challenges/Open Problems, NLP Abstraction levels, Introduction to NL computing techniques and steps (segmentation, tagging, parsing, etc.)
  b) NLP Tasks:
  Segmentation, Chunking, Tagging, Named Entity Recognition (NER), Parsing, Word Sense Disambiguation, NL Generation, Text Processing Challenges
	15 Hrs
	[OC1]

Unit II
 	
  a) Morphological Analysis and Regular Expressions:
  Introduction to Morphology, Types of morphological parsing: rule-based vs. paradigm-based, Regular Expressions and Automata Finite State Automata (FSA) and Finite State Transducers (FST), Introduction to the Porter stemming algorithm.
 	
  b) Part-of-Speech (POS) Tagging and Evaluation:
  Word Classes and Introduction to POS Tagging, Survey of POS tagsets in English and Indian languages, Introduction to rule-based approaches like ENGTOWL, Stochastic Approaches: Overview of probabilistic models, N-gram models, and Hidden Markov Models (HMM) for POS tagging, Transformation-Based Learning (TBL) Morphology, Evaluation Metrics and Error Analysis: Precision, Recall, F-measure, error-analysis
	15 Hrs
	[OC2-OC3]

MODULE II:	**(2 CREDITS)**

Unit III
 	
  a) NL Parsing Basics and Grammar Formalisms:
  Introduction to NL Parsing (top-down and bottom-up parsing approaches), Introduction to constituency and dependency schools of grammar, Overview of grammar notations: CFG, LFG, PCFG, LTAG, Overview of English CFG, Introduction to Paninian Karaka Theory for Indian language parsing, Overview of CFG parsing using Earley's and CYK algorithms, Introduction to Paninian Karaka Theory for Indian language parsing, Overview of CFG parsing using Earley's and CYK algorithms.
 	
  b) Probabilistic Parsing and Dependency Parsing:
  Introduction to probabilistic parsing techniques, Overview of probabilistic CFG (PCFG) and its applications, dependency parsing and its importance, Overview of Covington algorithm, MALT parser, and MST parser for dependency parsing.
	15 Hrs
	[OC4]

Unit IV
 	
  a) Lexical Semantics and Word Senses:
  Introduction to semantic analysis theories and methodologies, lexical semantics, word senses, and relationships, Introduction to WordNet for English and IndoWordnet, Overview of WSD techniques like Lesk Algorithm and Walker's algorithm, Importance of WSD in resolving ambiguity in NLP.
 	
  b) Coreference Resolution and Semantic Representations:
  coreference resolution, including Anaphora and Cataphora, Importance of resolving coreference in NLP applications, Semantic Representations and Word Similarity and understanding lexical semantics.
	15 Hrs
	[OC5]

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Handbook of Natural Language Processing	Indurkhya, N., & Damerau, F. J.	CRC Press Taylor and Francis Group	2nd	2010
2.	Speech and Language Processing	Martin, J. H., & Jurafsky, D.	Pearson Education India	2nd	2013
3.	Foundations of Statistical Natural Language Processing	Manning, Christopher and Heinrich, Schutze	MIT Press	1st	1997
4.	Natural Language Processing With Python	Steven Bird, Edward Loper	O'Reilly Media	2nd	2016

Video Links
1. http://www.nptelvideos.in/2012/11/natural-language-processing.html

Course Outcomes (OCs)

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

OC1: Students will get idea about know-hows, issues and challenge in Natural Language Processing and NLP applications and their relevance in the classical and modern context.

OC2: Student will get understanding of Computational techniques and approaches for solving NLP problems and develop modules for NLP tasks and tools such as Morph Analyzer, POS tagger, Chunker, Parser, WSD tool etc.

OC3: Students will also be introduced to various grammar formalisms, which they can apply in different fields of study.

OC4: Students can take up project work or work in R&D firms working in NLP and its allied areas.

OC5: Student will be able to understand applications in different sectors

Programme Code: _____   **Programme Name: M.Sc. (Information Technology**

Course Code: 606b [Elective]	**Course Name:** Security Operations Center Practical
Total Credits: 04 (120 Practical Hrs)	**Total Marks:** 100 marks
University assessment: 50 marks	**College/Department assessment:** 50 marks

Prerequisite:

1. Sound knowledge of Networking
2. Sound knowledge of operating system such as windows OS and LinuxOS
3. Sound Knowledge of Network Security and database.

Course Objectives (COs):

To enable the students to:

CO1: Learn encryption, decryption, and hashing techniques.

CO2: Analyze network traffic using Wireshark, focusing on Telnet, SSH, HTTP, and HTTPS protocols.

CO3: Investigate attacks on Windows hosts, and Utilize intrusion detection systems like Snort and implement firewall rules.

CO4: Extract executables from network traffic, explore DNS traffic, and perform attacks on MySQL databases.

C05: Set up syslog servers, configure Linux systems for logging, and work with log management tools like Splunk, ELK, and GrayLog.

Prac No	Practical Description		4CREDITS (120 hrs)
1	a.	Encrypting and Decrypting Data Using a Hacker Tool	6 hrs [OC1,OC2]
	b.	Encrypting and Decrypting Data Using OpenSSL	
	c.	Hashing a Text File with OpenSSL and Verifying Hashes	
2	a.	Examining Telnet and SSH in Wireshark	6 hrs [OC3,OC4]
	b.	Investigating an Attack on a Windows Host	
	c.	Investigating a Malware Exploit	
3	a.	Demonstrate the use of Snort and Firewall Rules	6 hrs [OC5,OC6]
	b.	Demonstrate Extract an Executable from a PCAP	
	c.	Demonstrate a practical for Exploring DNS Traffic	
4	a.	Using Wireshark to Examine HTTP and HTTPS Traffic	6 hrs [OC7,OC8]
	b.	Exploring Processes, Threads, Handles, and Windows Registry	

5	Perform a practical to Attack on a mySQL Database by using PCAP file.	6 hrs [OC9]
6	Create your own syslog Server	6 hrs [OC10]
7	Configure your Linux system to send syslog messages to a syslog server and Read them	6 hrs [OC10]
8	Install and Run Splunk on Linux	6 hrs [OC11]
9	Install and Configure ELK on Linux	6 hrs [OC11]
10	Install and Configure GrayLog on Linux	6 hrs [OC11]

Course Outcomes(OCs)

After completion of the course, students able to

OC1: To perform encryption and decryption data using various tools, including OpenSSL and a hacker tool.

OC2: Understand the concept of hashing text files with OpenSSL and verifying hashes.

OC3: Gain the proficiency in examining Telnet and SSH traffic using Wireshark.

OC4: Improvising the skills in investigating attacks on Windows hosts and malware exploits.

OC5: Gain a knowledge of using Snort and firewall rules for network security.

OC6: Capability to extract executables from PCAP files and explore DNS traffic.

O7: Demonstrate competence in analyzing HTTP and HTTPS traffic using Wireshark.

OC8: Understand the concept of processes, threads, handles, and the Windows Registry.

OC9: Gain proficiency in attacking a MySQL database using PCAP files.

OC10: Create and configure a syslog server and read syslog messages.

OC11: Develop skills in installing and running Splunk, ELK, and GrayLog on Linux.

Programme Code:____   Programme Name: <u>M.Sc. (Information Technology</u>

Course Code: (606c) [Elective] Total Credits: 04 (120 Lecture Hrs) University assessment: 50 marks	Course Name: Server Virtualization on VMWare Platform (PR) Total Marks: 100 marks College/Department assessment: 50 marks

Prerequisite:
   1. Sound knowledge of Virtualization

Course Objectives (COs):
To enable the students to:
- To get the insight of Vmware products implementation
- To understand the concepts behind the vCenter Appliance.
- To understand the concepts behind the VMFS,vMotion,HA

Prac No	Practical Description	4 CREDITS (120 hrs)

1	Deploying and Configuring Virtual Machines
	   1. Access Your Student Desktop
	   2. Create a Virtual Machine
	   3. Install VMware Tools
	   4. Copy Files to the Desktop
		6 hrs
		[OC1,]

2	Working with vCenter Server Appliance
	   1. Access your vCenter Server Appliance and Configure Licenses
	   2. Configure Single Sign-On and Create a Data Center Object
	   3. Add Your ESXi Hosts to the vCenter Server Inventory
	   4. Configure the ESXi Hosts as NTP Clients
	   5. Create a Host and Cluster Folder.
	   6. Create Virtual Machine and Template Folders.
	
	   7. Navigate vSphere Client
		6 hrs
		[OC2]

3	Users, Groups, and Permissions
	   1. Join the vCenter Server Appliance to vclass.local Domain
	   2. Add vclass.local as an Identity Source .
	   3. View Active Directory Users.
	   4. Assign Object Permissions to an Active Directory User
	   5. Assign Root-Level Global Permission
	   6. Log In with Windows Session Authentication
	   7. Use an Active Directory User to Manage a Virtual Machine
		6 hrs
		[OC3]

4	Using Standard Switches
	   1. View the Standard Switch Configuration
	   2. Create a Standard Switch with a Virtual Machine Port Group . .
		6 hrs
		[OC4]

	3. Attach Your Virtual Machines to the New Virtual Machine Port Group	

5	Accessing iSCSI Storage
	    1. Validate an Existing ESXi Host iSCSI Configuration
	    2. Add a VMkernel Port Group to a Standard Switch
	    3. Configure the iSCSI Software Adapter
	    4. Connect the iSCSI Software Adapters to Storage
		6 hrs
		[OC5]

6	Managing VMFS Datastores
	    1. Create VMFS Datastores for the ESXi Host
	    2. Expand a VMFS Datastore to Consume Unused Space on a LUN.
	    3. Remove a VMFS Datastore.
	    4. Extend a VMFS Datastore
	    5. Create a Second Shared VMFS Datastore Using iSCSI
		6 hrs
		[OC6]

7	Accessing NFS Storage
	    1. Configure Access to NFS Datastores
	    2. View NFS Storage Information
		6 hrs
		[OC7]

8	Using Templates and Clones
	    1. Create a Virtual Machine Template
	    2. Create Customization Specifications
	    3. Deploy a Virtual Machine from a Template
		6 hrs
		[OC8]

9	Modifying Virtual Machines
	    1. Clone a Powered-On Virtual Machine
	    2. Increase the Size of a VMDK File
	    3. Adjust Memory Allocation on a Virtual Machine.
	    4. Rename a Virtual Machine in the vCenter Server Appliance Inventory
	    5. Add and Remove a Raw LUN on a Virtual Machine
		6hhrs
		[OC9]

10	Migrating Virtual Machines .
	Migrate Virtual Machine Files from Local Storage to Shared Storage
	    1. Create a Virtual Switch and a VMkernel Port Group for vSphere vMotion Migration .
	    2. Prepare Virtual Machines to Demonstrate vSphere vMotion Migration
	    3. Perform vSphere vMotion Migrations of Virtual Machines
	    4. Perform Compute Resource and Storage Migrations
		6 hrs
		[OC10]

11	Managing Virtual Machines.
	    1. Unregister a Virtual Machine from the vCenter Server Appliance Inventory
	    2. Register a Virtual Machine in the vCenter Server Appliance Inventory .
	    3. Unregister and Delete Virtual Machines from the Datastore .
		6 hrs
		[OC11]

	4. Take Snapshots of a Virtual Machine 5. Add Files and Take Another Snapshot of a Virtual Machine . 6. Revert the Virtual Machine to a Snapshot 7. Delete an Individual Snapshot 8. Delete All Snapshots.	

12	Managing Resource Pools .
	   1. Create CPU Contention .
	   2. Create Resource Pools .
	   3. III. Verify Resource Pool Functionality
		6 hrs
		[OC12]

13	Monitoring Virtual Machine Performance .
	   1. Create the CPU Workload . .
	   2. Use Performance Charts to Monitor CPU
	   3. III. Undo Changes Made to the Virtual Machines
		6hrs
		[OC13]

14	Using vSphere HA. . . .
	   1. Create a Cluster Enabled for vSphere HA
	   2. Add Your ESXi Hosts to the Cluster
	   3. Test the vSphere HA Functionality
	   4. View the vSphere HA Cluster Resource Usage.
	   5. Manage vSphere HA Slot Size
	   6. Configure a vSphere HA Cluster with Strict Admission Control
		6 hrs
		[OC14]

Course Outcomes(OCs)

After completion of the course:

OC1:.Creating and Virtual Machines and their
OC2: deployment of Working with vCenter Server Appliance
OC3: Understanding the Users, Groups, and Permissions
OC4: Using various types of switches
OC5: Accessing iSCSI Storage /Network Storage
OC6: Managing VMFS Datastores and the data storage
OC7: Accessing NFS Storage
OC8: Using Templates and Clones
OC9: Modifying Virtual Machines
OC10: Migrating Virtual Machines .
OC11: Managing Virtual Machines status and snap shots
OC12: Managing Resource Pools .
OC13: Monitoring the performance of Virtual Machine
OC14:Understanding and implementing High Availability Cluster

Semester IV

Programme Code:____	Programme Name: M.Sc. (Information Technology
Course Code: 611 [Mandatory]	**Course Name:** Blockchain (Theory)
Total Credits: 04 (60 Lecture Hrs)	**Total Marks:** 100 marks
University assessment: 50 marks	**College/Department assessment:** 50 marks

Pre requisite:
1. knowledge of data structure and cryptography
2. Sound knowledge of one popular language, such as Java or Python

Course Objectives (COs)

To enable the students to:

CO1 : understand the structure of a Blockchain

CO2 : learn the fundamentals of Ethereum and Bitcoin.

CO3 : gain a comprehensive understanding of smart contract and Dapp.

CO4 : learn the concepts of permissioned and public blockchains and NFT.

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MODULE I:	(2 CREDITS)
Unit 1: Blockchain Introduction a. **Blockchain** – Introduction, History, Centralised versus Decentralised systems, Layers of blockchain, Importance of blockchain, Blockchain uses and use cases. b. **Working of Blockchain** – Blockchain foundation, Cryptography, Game Theory, Computer Science Engineering, Properties of blockchain solutions, blockchain transactions, distributed consensus mechanisms, Blockchain mechanisms, Scaling blockchain.	15 Hrs [OC1]

Unit 2: Bitcoin and Ethereum
  a. **A Working of Bitcoin:** Money, Bitcoin, Bitcoin blockchain, bitcoin network, bitcoin scripts, Full Nodes and SVPs, Bitcoin wallets, Interacting with the Bitcoin Blockchain
  b. **Ethereum**- Ethereum as a Next-Gen Blockchain, Design Philosophy of Ethereum, Ethereum Blockchain, Ethereum Accounts, Advantages of Accounts, Account State, Merkle Patricia Tree, Ethereum Transaction and Message Structure, Ethereum State Transaction Function, Gas and Transaction Cost, Ethereum Smart Contracts, Contract Creation, Ethereum Virtual Machine.
  c. **Mining Ether**: Difficulty, Factors Required for Block Validation, How Proof of Work Helps Regulate Block Time, Faster Blocks, How Ethereum Uses Stale Blocks, Forking
	15 Hrs [OC2]

MODULE II :	(2 CREDITS)
Unit 3: Smart Contract & Dapp a. **Smart Contracts and Solidity:** Basic of Solidity Programming:- writing loops in solidity, statement and expressions in solidity, Value types, Global special variables, Units and Functions	15 Hrs [OC3]

b. **Behind Dapp Deployment**-Seven Ways to Think About Smart Contracts, Smart Contract Deployment- EVM as Back End: Introduction to Truffle, Use of Remix and test networks for deployment, Dapp deployment. c. **Blockchain Application Development** -Decentralized Applications, , Interacting Programmatically with Ethereum—Sending Transactions, Creating a Smart Contract, Executing Smart Contract Functions	
Unit 4: Permissioned Blockchain ,Cryptoeconomics & NFT a. **Permissioned Blockchain**-, Public vs. Private Blockchains, Decentralized Application Architecture, Hyperledger concept, Exploring Hyperledger fabric project, Iroha project b. **Cryptoeconomics**- Why Is Cryptoeconomics useful?, Understanding Hashing vs.encryption,Speed of blocks, Ether Issuance scheme, Common Attack Scenarios c. **NFT**- What are NFTs?NFT Marketplaces,Creating and Minting NFTs,Legal Aspects of NFTs, The Future of NFTS	15 Hrs [OC 4]

References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Introducing Ethereum and Solidity	Chris Dannen	Apress		2017
1.	Beginning Blockchain: A Beginner's Guide to Building Blockchain Solutions	Bikramaditya Singhal , Gautam Dhameja ,Priyansu Sekhar Panda	Apress		2018
1.	Blockchain for dummies	Tiana Laurence	Wiley		2017
1.	The Blockchain Developer	Elad Elrom	Apress		2019
1.	Mastering Ethereum	Andreas M. Antonopoulos Dr. Gavin Wood	O'Reilly	First	2018
1.	The NFT Handbook	Matt Fortnow,Terry	Wiley		2022

Online References:
1. NPTEL courses:
   a. Blockchain and its Applications,
   b. Blockchain Architecture Design and Use Cases
2. www.swayam.gov.in/
3. www.coursera.org
4. https://ethereum.org/en/
5. https://www.trufflesuite.com/tutorials
6. https://hyperledger-fabric.readthedocs.io/en/release-2.2/whatis.h

7. Blockchain demo: https://andersbrownworth.com/blockchain/
8.BlockchainDemo:Public/PrivateKeys&signing:
https://andersbrownworth.com/blockchain/public-private-keys/
9.https://www.javatpoint.com/blockchain-tutorial
10. https://www.tutorialspoint.com/blockchain/index.htm

Course Outcomes(OCs)
After completion of the course, a student should be able to:
1. provide conceptual understanding of the function of Blockchain as a method of securing distributed ledgers, how consensus on their contents is achieved.
2. demonstrate blockchain applications.
3. gain the ability to write and deploy basic smart contracts on the Ethereum blockchain using Solidity programming language and tools like Truffle and Remix**.**
4. able to analyze cryptoeconomic design and learn NFT and permissioned blockchains.

Programme Code:_____   Programme Name: M.Sc. (Information Technology

Course Code:612 [Mandatory]	**Course Name:** Blockchain Practical
Total Credits: 02 (60 Lecture Hrs)	**Total Marks:** 50 marks
University assessment: 25 marks	**College/Department assessment:** 25 marks

Prerequisite:
1. Proficiency in programming languages like Python, JavaScript
2. Familiarizing yourself with Ethereum, its architecture, and the Solidity programming language

Course Objectives (COs):
To enable the students to:

1. recognize the importance of blockchain in various industries and its potential to disrupt traditional systems.
2. analyze the structure and functionality of Bitcoin wallets for storing and managing cryptocurrency.
3. introduce the Ethereum Virtual Machine (EVM) as the backend for executing smart contracts.
4. explore the permissioned blockchain.

Unit	Sr No	**Practical Description**	**2 CREDITS (60 hrs)**
		Blockchain	
1	a	Develop a secure messaging application where users can exchange messages securely using RSA encryption. Implement a mechanism for generating RSA key pairs and encrypting/decrypting messages.	OC1 (15 hrs)
	b	Allow users to create multiple transactions and display them in an organised format.	
	c	Create a Python class named Transaction with attributes for sender, receiver, and amount. Implement a method within the class to transfer money from the sender's account to the receiver's account..	
	d	Implement a function to add new blocks to the miner and dump the blockchain.	
2	a	Write a python program to demonstrate mining.	OC2 (15 hrs)
	b	Demonstrate the use of the Bitcoin Core API to interact with a Bitcoin Core node.	
	c	Demonstrating the process of running a blockchain node on your local machine.	
	d	Demonstrate mining using geth on your private network.	

3	a	Write a Solidity program that demonstrates various types of functions including regular functions, view functions, pure functions, and the fallback function.	OC3 (15 hrs)
	b	Write a Solidity program that demonstrates function overloading, mathematical functions, and cryptographic functions.	
	c	Write a Solidity program that demonstrates various features including contracts, inheritance, constructors, abstract contracts, interfaces.	
	d	Write a Solidity program that demonstrates use of libraries, assembly, events, and error handling.	
	e	Build a decentralized application (DApp) using Angular for the front end and Truffle along with Ganache CLI for the back end.	
4	a	Install and demonstrate use of hyperledger-Irhoa	OC4 (15 hrs)
	b	Demonstration on interacting with NFT	

Upon completing this course, the student will be able to:
  OC1. develop a mechanism for generating RSA key pairs, enabling users to securely encrypt and decrypt messages.
  OC2. explore the architecture and components of the Bitcoin blockchain, including blocks, transactions.
  OC3. demonstrate smart contracts and their deployment in decentralized applications (DApps).
  OC4. evaluate the security and privacy challenges in blockchain systems.

Programme Code:_____ **Programme Name: M. Sc. (Information Technology)**

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

Course Objectives: (COs)

To enable students to:

CO1: To present the mathematical, statistical and computational challenges of building Neural networks
CO2: To study the concepts of deep learning
CO3: To enable the students to know deep learning techniques to support real-time Applications

MODULE 1	2 Credits
UNIT I **a) Applied Math and Machine Learning Basics:** Linear Algebra: Scalars, Vectors, Matrices and Tensors, Multiplying Matrices and Vectors , Identity and Inverse Matrices, Linear Dependence and Span , norms, special matrices and vectors, Eigen decompositions. **b) Numerical Computation:** Overflow and under flow, poor conditioning, Gradient Based Optimization, Constraint optimization. **UNIT II** **a) Deep Networks:** Deep feed forward network, regularization for deep learning, Optimization for Training deep models.	**30 Hrs** **[OC1, OC2, OC3]**
MODULE 2	2 Credits
UNIT III **a) Convolution Applications:** Convolutional Networks, Sequence Modelling, Applications **b) Deep Learning Research:** Linear Factor Models, Auto encoders, representation learning **UNIT IV** **a) Generative Models:** Approximate Inference, Deep Generative Models **b) Diffusion Models (Reference 3)** **c) Applications:** Transformers, Advance GANs **(Reference 3)**	**30 Hrs** **[OC4, OC5]**

Course Outcomes:

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

CO1: Describe basics of mathematical foundation that will help the learner to understand the Concepts of Deep Learning.
CO2: Understand and describe model of deep learning
CO3: Understand various deep supervised learning architectures for text & image data.
CO4: Gain knowledge about various deep learning models and architectures.
CO5: Familiarize various deep learning techniques to design efficient algorithms for real-world applications.

Books and References:					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1	Deep Learning Ian Goodfellow,	Yoshua Bengio, Aaron	An MIT Press book	1st	2016
2	Fundamentals of Deep Learning	Nikhil Buduma	O'Reilly	1st	2017
3	Generative Deep Learning	David Foster	O'Reilly	2nd	2023
4	Deep Learning: Methods and Applications	Deng & Yu	Now Publishers	1st	2013
5	Deep Learning CookBook	Douwe Osinga	O'Reilly	1st	2017

Programme Code:____   **Programme Name: <u>M.Sc. (Information Technology)</u>**

Course Code:614 **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:
Basic understanding of Deep learning frameworks TensorFlow, PyTorch, Keras etc..

Course Objectives (CO)

CO1   To learn to use popular frameworks like TensorFlow or PyTorch to construct, train, and evaluate deep learning models for various tasks.

CO2   To apply various deep learning techniques to design efficient algorithms for real-world applications.

CO3   To optimize and deploy trained models into production environments.

CO4   To gain the ability to analyze problems, select appropriate deep learning approaches, evaluate model performance, and troubleshoot issues.

Sr.No.	Practical List	2 Credits
1.	**Introduction to TensorFlow**	OC1
a.	- Create tensors with different shapes and data types. - Perform basic operations like addition, subtraction, multiplication, and division on tensors. - Reshape, slice, and index tensors to extract specific elements or sections. - Performing matrix multiplication and finding eigenvectors and eigenvalues using TensorFlow	
b.	Program to solve the XOR problem.	
2.	**Linear Regression**	OC2,OC3, OC4
a.	- Implement a simple linear regression model using TensorFlow's low-level API (or `tf. keras`). - Train the model on a toy dataset (e.g., housing prices vs. square footage). - Visualize the loss function and the learned linear relationship. - Make predictions on new data points.	
3	**Convolutional Neural Networks (Classification)**	OC2,OC3,OC4
a.	Implementing deep neural network for performing binary classification task	
b.	Using a deep feed-forward network with two hidden layers for performing multiclass classification and predicting the class.	
4	Write a program to implement deep learning Techniques for image segmentation.	OC2,OC3,OC4
5	Write a program to predict a caption for a sample image using LSTM.	OC2,OC3,OC4

6	Applying the Autoencoder algorithms for encoding real-world data	OC2,OC3,OC4
7.	Write a program for character recognition using RNN and compare it with CNN.	OC2,OC3,OC4
8.	Write a program to develop Autoencoders using MNIST Handwritten Digits	OC2,OC3,OC4
9.	Demonstrate recurrent neural network that learns to perform sequence analysis for stock price.(google stock price)	OC2,OC3,OC4
10.	Applying Generative Adversarial Networks for image generation and unsupervised tasks.	OC2,OC3,OC4

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1	Deep learning with TensorFlow	Giancarlo Zaccone Md. Rezaul Karim	Packt	2nd	2018
2	Zero to Deep Learning	Francesco Mosconi	Fullstack.io	1st	2019

Course Outcomes (OCs)

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

OC1: Use tensors to implement deep learning algorithms and techniques.

OC2: Apply deep neural network models.

OC3: Analyze the impact of hyperparameter tuning on optimization.

OC4: Evaluate and visualize the performance of the model.

Programme Code:_____   **Programme Name: <u>M.Sc. (Information Technology)</u>**

Course Code: 615a [Elective]	**Course Name:** Robotic Process Automation (PR)
Total Credits: 04 (120 Lecture Hrs)	**Total Marks:** 100 marks
University Assessment: 50 marks	**College/Department Assessment:** 50 marks

Prerequisite:

- Basic knowledge of software coding and programming logic.

Course Objectives:

1. : UiPath Fundamentals: Learn UiPath RPA basics, including Studio and Orchestrator.

2. : Workflow Design: Develop automation workflows efficiently with UiPath Studio.

3. : Data Manipulation: Extract, transform, and integrate data using UiPath.

4. : Error Management: Handle exceptions and ensure reliable automation.

5. : Orchestrator Management: Configure and monitor Orchestrator for robot management.

6. : Advanced Features: Explore advanced UiPath capabilities like OCR and web automation.

Prac No	Practical Description	4 CREDITS (120 hrs)
	Module 1:	
1.	**RPA Basics: Sequences and Flowcharts:** a. Create a simple sequence-based project. b. Create a flowchart-based project. c. Automate UiPath Number Calculation (Subtraction, Multiplication, Division of numbers). d. Create an automation UiPath project using different types of variables (number, datetime, Boolean, generic, array, data table)	10 hrs [OC1, OC2]
2.	**Decision making and looping:** a. 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. b. Demonstrate switch statement with an example. c. Create an automation To Print numbers from 1 to 10 with break after the writeline activity inside for each activity d. Create an automation using Do..While Activity to print numbers from 5 to 1 e. Create an automation using Delay Activity between two writeline activities to separate their execution by 5 seconds f. Create an automation to demonstrate use of decision statements (if)	10 hrs [OC1,OC2]
3.	**Types of Recording:** a. Basic Recording using Toolbar	10 hrs [OC3,

	b. Basic Recording using Notepad	OC4]
	c. Desktop Recording using Tool bar	
	d. Desktop Recording by creating a workflow	
	e. Web Recording e.g. Find the rating of the movie from imdb web site	
	f. Web Recording manually	
	Module 2:	
4.	**Excel Automation:**	
	a. Automate the process to extract data from an excel file into a data table and vice versa	
	b. Create an automation to Write data to specific cell of an excel sheet.	10 hrs [OC3, OC4]
	c. Create an automation to Read data to specific cell of an excel sheet.	
	d. Create an automation to append data to specific cell of an excel sheet.	
	e. Create an automation to sort a table of an excel sheet.	
	f. Create an automation to filter a table of an excel sheet	
	g. Choose a repetitive manual task from your workplace or daily life. Design and implement an RPA bot to automate this task using your preferred RPA tool	
5.	**Different controls in UiPath:**	
	a. Implement the attach window activity.	
	b. Automate using Anchor Base.	12 hrs [OC4, OC5]
	c. Automate using Element Exists.	
	d. Automate using Find Children control.	
	e. Use Get Ancestor control	
	f. Use Find Relative control	
6.	**Keyboard and Mouse Events:**	
	a. Demonstrate the following activities in UiPath:	
	i. Mouse (click, double click and hover)	
	ii. Type into	
	iii. Type Secure text	12 hrs [OC2, OC3]
	b. Demonstrate the following events in UiPath:	
	. Element triggering event	
	i. Image triggering event	
	ii. System Triggering Event	
	c. Automate the process of launching an assistant bot on a keyboard event.	
	Module 3:	
7.	**Screen Scraping and Web Scraping methods:**	
	a. Automate the following screen scraping methods using UiPath:	
	a. Full Text	12 hrs [OC3, OC4]
	b. Native	
	c. OCR	
	b. Demonstrate Data Scraping and display values in Message box.	
	c. Demonstrate Screen Scraping for a pdf, web page and image file.	
8.	**PDF Automation and Exception Handling:**	
	a. Read PDF With OCR	
	b. Merge PDF's into one	
	c. Get PDF Total Page count Using Regex	12 hrs [OC3, OC4]
	d. Extract data from a PDF or Excel file and populate it into a database or spreadsheet.	
	e. Extract data from a PDF or Excel file and populate it into a database or spreadsheet. Implement data manipulation techniques like filtering, sorting, or data validation.	

	f. Demonstrate Exception Handling using UiPath	
9.	**Email Automation:** a. Configure Email using UiPath b. Read Emails c. Send Email with Attachment d. Save Email Attachments e. Reply to Email	12 hrs [OC4, OC5]
	Module 4:	
10.	**Orchestrator management and mini project:** a. Deploy bots to Orchestrator b. Run jobs from Orchestrator c. Queue Introduction: i. Add items to Queue. i. Get Queue item from Orchestrator d. Build UiPath Chatbot using Google dialogflow	12 hrs [OC4, OC5]
11.	**RPA Applications:** a. Automate the extraction of data from invoices, validate information, and update accounting systems. b. Automate data entry tasks from various sources such as emails, forms, or documents, and validate data against predefined rules. c. Automate the process of expense reporting by extracting data from receipts, categorizing expenses, and generating reports. d. Automate inventory tracking and management processes, including stock updates, reordering, and inventory audits. **e.** Automate sales order processing tasks such as order entry, validation, and fulfilment.	10 hrs [All OC's]
12.	**Prepare the Robotics process automation project on any one of the following domains:** RPA in Logistics, Intelligent Process Automation, IT Process Automation Explained, RPA in Banking, RPA in Education, RPA in Telecommunications, RPA in Healthcare, RPA in Insurance, RPA in Accounting, RPA Challenges, RPA in Real Estate, RPA in BPO, RPA Security	10 hrs [All OC's]

Course Outcomes (OC's):

Upon the successful completion of this course, students will be able to:
1. : Recall and describe fundamental RPA and UiPath concepts, including key features of Studio and Orchestrator.
2. : Explain RPA principles and how UiPath facilitates process automation through its mechanisms.
3. : Interpret roles of components and tools in the UiPath ecosystem, understanding their functions.
4. : Summarize UiPath's data manipulation and integration capabilities for efficient automation.
5. : Utilize UiPath Studio to create workflows for simple business processes, incorporating data extraction and manipulation techniques.

Programme Code: ____   **Programme Name:** <u>M.Sc. (Information Technology)</u>

Course Code: 615b [Elective] **Total Credits:** 04 (120 Lecture Hrs) **University assessment:** 50 marks	**Course Name:** Cyber Forensics Practical **Total Marks:** 100 marks **College/Department assessment:** 50 marks

Prerequisite:
1. Sound knowledge of Networking
2. Sound knowledge of operating system such as windows OS and LinuxOS
3. Sound Knowledge of Network Security and database

Course Objectives (COs):

To enable the students to:

CO1: Understand the fundamentals of computer forensics investigation processes and methodologies.

CO2: Gain proficiency in using various forensic tools and techniques for data recovery, analysis, and preservation.

CO3: Develop skills in detecting and defeating anti-forensic techniques employed by perpetrators.

CO4: Learn how to perform forensic investigations on different operating systems, networks, web attacks, databases, malware, email crimes, and mobile devices.

CO5: Apply acquired knowledge and skills through practical exercises and case studies to conduct thorough and effective forensic investigations.

Prac No	Practical Description	2 CREDITS (60 hrs)
1	**Computer Forensics Investigation Process** a.　　　Recovering Data using the EaseUS Data Recovery Wizard. b.　　　Performing Hash, Checksum, or HMAC Calculations using the HashCalc. **c.**　　　Creating a Disk Image File of a Hard Disk Partition using the R-drive Image Tool.	6 hrs [OC1, OC2, OC3]
2	**Understanding Hard Disks and File Systems** a.　　　Analyzing File System Types Using the Sleuth Kit (TSK). b.　　　Analyzing Raw image using Autopsy. c.　　　Analyze file system of Linux image file. **d.**　　　Analyze file system of Windows image file.	6 hrs [OC4]

3	**Data Acquisition and Duplication** a. Creating a dd image file b. Investigating NTFS Drive Using DiskExplorer for NTFS. c. Viewing Content of Forensic Image Using Access Data FTK Imager Tool	6 hrs [OC5]
4	**Defeating Anti-forensics Techniques** a. Cracking Application Password **b.** Detecting Steganography c. Perform a practical of identifying the packer used to pack a file by using ExeInfo PE and then unpacking the file using UPX.	6 hrs [OC6]
5	**Performing OS Forensics** a. Performa a Practical collect volatile information from a host computer running on a Windows OS by using tools PsTools, LogonSessions, and NetworkOpenedFiles. b. Performa a Practical for Discovering and Extracting Hidden Forensic Material on Computers Using OSForensics. c. Performing a Computer Forensic Investigation Using the Helix Tool d. examine Windows event logs using Event Log Explorer.	6 hrs [OC7]
6	**Network Forensics** a. Investigating Network Traffic Using Wireshark b. Investigating Network Attacks using Kiwi Log Viewer	6 hrs [OC8]
7	**Investigating Web Attacks** a. Analyzing Domain and IP Address Queries Using SmartWhois Tool	6 hrs [OC9]
8	**Database Forensics** a. Analyzing SQLite Databases using DB Browser for SQLite	6 hrs [OC10]
9	**Malware Forensics** a. Perform Static Analysis of the Suspicious File **b.** performing dynamic analysis of a malicious file to find the processes It starts, network operations, file changes and other activities.	6 hrs [OC11]
10	**Investigating Email Crimes** a. Recovering Deleted Emails Using the Recover My Email utility. **b.** Tracing an Email Using the eMailTrackerPro Tool.	6 hrs [OC12]
11	**Mobile Forensics** a. Analyzing the Forensic Image and Carving the Deleted Files Using Autopsy.	3 hrs [OC13]

Course Outcomes(OCs)

After completion of the course:

OC1: Data Recovery: Students will be able to recover lost or deleted data using tools like EaseUS Data Recovery Wizard, ensuring data integrity and completeness during investigations.

OC2: Hashing and Checksum Calculations: Students will perform hash, checksum, or HMAC calculations using HashCalc, enabling them to verify data integrity and authenticity.

OC3: Disk Imaging: Students will create disk image files of hard disk partitions using tools like R-drive Image Tool, ensuring preservation of evidence for analysis.

OC4: File System Analysis: Students will analyze different file system types using Sleuth Kit (TSK) and Autopsy, enabling them to understand file structures and recover relevant evidence.

OC5: Data Acquisition and Duplication: Students will create dd image files, investigate NTFS drives using DiskExplorer for NTFS, and view content of forensic images using FTK Imager Tool, ensuring accurate and thorough data acquisition.

OC6: Defeating Anti-Forensics Techniques: Students will learn to crack application passwords, detect steganography, and identify and unpack packed files using tools like ExeInfo PE and UPX, ensuring effectiveness in overcoming anti-forensics measures.

OC7: OS Forensics: Students will collect volatile information from Windows hosts using PsTools, LogonSessions, and NetworkOpenedFiles, discover and extract hidden forensic material using OSForensics, and perform computer forensic investigations using Helix Tool, enabling them to conduct thorough examinations of operating systems.

OC8: Network Forensics: Students will investigate network traffic using Wireshark and analyze network attacks using Kiwi Log Viewer, enabling them to identify and analyze network-related evidence effectively.

OC9: Web Attacks Investigation: Students will analyze domain and IP address queries using SmartWhois Tool, enabling them to investigate web-related attacks and activities.

OC10: Database Forensics: Students will analyze SQLite databases using DB Browser for SQLite, enabling them to extract and analyze data stored in databases for forensic purposes.

OC11: Malware Forensics: Students will perform static and dynamic analysis of suspicious files, enabling them to identify and analyze malware behavior and impact.

OC12: Email Crimes Investigation: Students will recover deleted emails using tools like Recover My Email utility and trace emails using eMailTrackerPro Tool, enabling them to investigate email-related crimes effectively.

OC13: Mobile Forensics: Students will analyze forensic images and carve deleted files from mobile devices using Autopsy, enabling them to conduct investigations involving mobile devices comprehensively.

Programme Code:____   **Programme Name: <u>M.Sc. (Information Technology)</u>**

Course Code: 615c [Mandatory]	**Course Name:** Advanced IoT (Practical<u>)</u>
Total Credits: 04 (120 Practical Hrs)	**Total Marks:** 100 marks
University assessment: 50 marks	**College/Department assessment:** 50 marks

Pre requisite:
1. Basics of IoT
2. Basics of Python Programming

Course Objectives (COs)
1. To understand how to load Raspbian and Windows IoT Core on Raspberry Pi and execute applications on it using Python and node.js.
2. To develop a home automation system that can remotely control at least 4 devices.
3. To learn how to interface the fingerprint module with Raspberry Pi, capture and store fingerprints and display whether the fingerprint is valid or not on the 16X2 LCD display.
4. To learn how to interface the RFID module with Raspberry Pi, write and read RFID cards, map them with student Roll no, and display information on the student.
5. To learn how to interface GPS module with Raspberry Pi and display the latitude and longitude on the 16X2 LCD display.
6. To learn how to interface the Pi Camera with Raspberry Pi, capture and store faces along with their names, scan the face and display the name of the person.
7. To develop a private Ethereum blockchain with Raspberry Pi.
8. To integrate Node Red with MQTT on Raspberry Pi.
9. To learn how to use Microsoft Speech API for transcribing, converting, and real-time speech translation.
10. To learn how to use Microsoft Language API to identify common terms, detect sentiments, enable natural language interaction, and translate languages. Additionally, to learn how to use Microsoft Vision API for identifying and analyzing content in images and videos, detect problems, offensive or unwanted content, and create personalized experiences for every user.

List of Practical:	
Unit 1	**15 hrs**
Load Raspbian and Windows IoT Core on Raspberry Pi and execute applications on it using Python and node.js.	[OC1]
Create a home automation system and control the devices remotely. Control 4 devices with the system.	[OC2]
Interface fingerprint module with raspberry Pi to capture and store fingerprints. Interface 16X2 LCD with the same Pi and display whether the fingerprint is valid or	[OC3]

invalid.	
Interface RFID module with Raspberry Pi. Write and read RFID cards. Map the with student Roll no. Read the card and display the information of the student.	[OC4]
Interface GPS module with Raspberry Pi. Display the latitude and longitude on the 16X2 LCD display.	[OC5]
Unit 2	**15 hrs**
Interface Pi Camera with Raspberry Pi. Capture and store faces along with their names. Scan the face and display the Name of the person.	[OC6]
a. Create a private Ethereum blockchain with Raspberry Pi. b. Integrate Node Red with MQTT on Raspberry Pi.	[OC7, OC8]
Interface fingerprint module with Raspberry Pi. Control different devices with fingerprint. If the finger print is registered and valid, the device should function, else Access denied should be displayed on LCD 16X2 display.	[OC14]

Create a full-featured Kubernetes application on a Pi cluster
        Setup Raspberry Pi Cluster
        Install Kubernetes on Raspberry Pi Cluster
        Install Kubernetes Ingress on Raspberry Pi Cluster
        Perform Kubernetes application monitoring on Raspberry Pi cluster
        Install MairaDB on Raspberry Pi
        Develop Application using the above installations
	[OC15]

Interface stepper motor with Raspberry Pi. Use the motor to rotate an item clockwise and anticlockwise in steps.	[OC16]
Build AI Powered Auto Billing System for Fast Checkout in Retail Stores with Raspberry Pi.	[OC17]
Send telemetry from a device to an IoT hub and read it with a service application.	[OC18]
Use the Azure CLI and Azure portal to configure IoT Hub message routing.	[OC18]
Use Microsoft Speech API to a. Transcribe audible speech into readable, searchable text. b. Convert text to lifelike speech for more natural interfaces. c. Integrate real-time speech translation into your apps. a. Identify and verify the person speaking by using voice characteristics.	[OC9, OC11]
Use Microsoft Language API to a. Identify commonly used and domain-specific terms. b. Automatically detect sentiments and opinions in text. c. Distill information into easy-to-navigate questions and answers. d. Enable your apps to interact with users through natural language. e. Translate more than 100 languages and dialects.	[OC10]
Use Microsoft Vision API to a. Identify and analyze content in images and video. b. Customize image recognition to fit your business needs.	[OC12, OC13]

Use Microsoft Language API to c. Identify potential problems early. (Decision services / Anomaly Detector) d. Detect potentially offensive or unwanted content. (Decision services / Content Moderator) e. Create rich, personalized experiences for every user. (Decision services / Personalizer)	
Develop a project for Condition monitoring for Industrial IoT (Case Study and Implementation)	[OC19]
Develop a project for Predictive maintenance for Industrial IoT (Case Study and Implementation)	[OC20]
Develop a project for Real-time asset tracking and management (Case Study and Implementation)	[OC21]
Create a digital model of your physical space or assets (Case Study and Implementation)	[OC22]

References:

1. https://www.raspberrypi.org/
2. https://betterprogramming.pub/develop-and-deploy-kubernetes-applications-on-a-raspberry-pi-cluster-fbd4d97a904c
3. https://learn.microsoft.com/en-us/azure/iot/tutorial-iot-industrial-solution-architecture
4. https://azure.microsoft.com/en-in/solutions/iot
5. https://circuitdigest.com/microcontroller-projects/raspberry-pi-based-automatic-library-management-system

Course Outcomes (OCs)
Upon completion of this practical course, learners will be able to:

1. Understand how to load Raspbian and Windows IoT Core on Raspberry Pi and execute applications on it using Python and node.js.
2. Develop a home automation system that can remotely control at least 4 devices.
3. Learn how to interface a fingerprint module with Raspberry Pi, capture and store fingerprints, and display whether the fingerprint is valid or invalid on the 16X2 LCD display.
4. Learn how to interface an RFID module with Raspberry Pi, write and read RFID cards, map them with student Roll no and display information on the student.
5. Learn how to interface a GPS module with Raspberry Pi and display the latitude and longitude on the 16X2 LCD display.
6. Learn how to interface a Pi Camera with Raspberry Pi, capture and store faces along with their names, scan the face and display the name of the person.
7. Develop a private Ethereum blockchain with Raspberry Pi.
8. Integrate Node Red with MQTT on Raspberry Pi.
9. Use Microsoft Speech API to transcribe, convert, and translate speech in real-time.
10. Use Microsoft Language API to identify common terms, detect sentiments and opinions, distill information, enable natural language interaction, and translate over 100 languages and dialects.

11. Identify and verify a person speaking by using voice characteristics.
12. Use Microsoft Vision API to identify and analyze content in images and video, and customize image recognition.
13. Identify potential problems early, detect potentially offensive or unwanted content, and create rich, personalized experiences for every user.
14. Develop the ability to interface a fingerprint module with Raspberry Pi and control different devices with fingerprint authentication. Display "Access denied" on the 16X2 display when invalid fingerprints are registered.
15. Learn how to set up a Raspberry Pi cluster, install Kubernetes and Ingress, monitor Kubernetes applications on Raspberry Pi, install MariaDB, and develop applications.
16. Understand how to interface a stepper motor with Raspberry Pi, rotate items clockwise and anti-clockwise in steps, and control the motor.
17. Develop skills for building an AI-powered auto-billing system for fast checkout in retail stores using Raspberry Pi.
18. Learn how to send telemetry from a device to an IoT hub and read it with a service application.
19. Develop the necessary knowledge and skills for implementing Condition Monitoring for Industrial IoT projects through a case study.
20. Develop the necessary knowledge and skills for implementing Predictive Maintenance for Industrial IoT projects through a case study.
21. Learn how to create a real-time asset tracking and management system.
22. Develop the ability to create a digital model of physical space or assets as part of a case study project.

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