AC: 29.06.2024
Item No.: 1.2.3

SIES (Nerul) College of Arts, Science & Commerce
RISE WITH EDUCATION

CELEBRATING 25 YEARS 1998-2023

SIES (Nerul) College of Arts, Science and Commerce (Autonomous)
M.Sc.(Information Technology)

Sr. No.	Heading	Particulars
1	Title of the course	M. Sc.(Information Technology) Part II
2	Eligibility for admission	B.Sc(IT,CS,AI,DS),B.E(IT,CS,Electronics,DS),BCA,B. Sc(Physics),B.Sc(Maths),B.Sc(Stats), B.Sc(Electronics)
3	Minimum Percentage for admission	40%
4	Passing Marks	40%
5	Semesters	III
6	Level	PG
7	Pattern	1-2 years & 2-4 semesters Choice Based Grading System
8	Status	New
9	To be implemented from	From Academic year 2024-25 in a progressive manner

Date: 29.06.2024
Signature:

Dr. Koel Roychoudhury
AC Chairperson

COLLEGE OF ARTS, SCIENCE AND COMMERCE (AUTONOMOUS) NERUL NAVI MUMBAI 400 706.

Dr.Anu Thomas
Head of the Department

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SIES (Nerul) College of Arts, Science and Commerce (Autonomous)
(Affiliated to University of Mumbai)
RE-ACCREDITED GRADE "A" BY NAAC (3rd CYCLE)

BOARD OF STUDIES
SYLLABUS FOR
M.Sc (Information Technology)

(WITH EFFECT FROM THE ACADEMIC YEAR 2024-2025)

OBJECTIVES OF THE PROGRAMME:

- Ability to apply the knowledge of Information Technology with recent trends aligned with research and industry.
- Ability to apply IT in the field of Computational Research, Soft Computing, Big Data Analytics, Data Science, Image Processing, Artificial Intelligence, Networking and Cloud Computing.
- Ability to provide socially acceptable technical solutions in the domains of Information Security, Machine Learning, Infrastructure Services as specializations.
- Ability to apply the knowledge of Intellectual Property Rights and Cyber Forensics and various standards in interest of National Security and Integrity along with IT Industry.
- Ability to write effective project reports, research publications and content development and to work in a multidisciplinary environment in the context of changing technologies.

M.Sc. Information Technology Programme

(To be implemented from Academic Year- 2024-25)

No. of Courses	Course Code	Semester III	Credits
1	Major		
1	M24IT3MJ01	Introduction to Predictive Analytics	4
2	M24IT3MJ02	Fundamentals of Deep Learning	4
3	M24IT3PMJ03	Practical's of Introduction to Predictive Analytics and Fundamentals of Deep learning	4
4	M24IT3MJ04	Understanding Generative AI	2
II	Electives(E) Electives to be done from NPTEL Repository.		
5	M24IT3E01	Basic Natural Language Processing	4
	M24IT3E02	Cyber Forensics	
III	M24IT3RP01	Research Project	4
Total Credits			22

Semester III

Major (Credit 4)

Introduction to Predictive Analytics

Course Code: M24IT3MJ01 **Course Credit: 4**

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objectives:

1. To understand the fundamental concepts of predictive analytics.
2. To impart the knowledge on various steps those are necessary before constructing the predictive model.
3. To gain knowledge on the assessment of predictive models for decision making

Course Outcome

Upon completion of the course the student will be able

1. Understand the fundamental concepts of predictive analytics.
2. Define the problem and prepare the data for analysis.
3. Construct different predictive models for decision making.
4. Apply descriptive modeling techniques for the given data.
5. Assess and interpret different predictive models.

UNIT	Topic	HRS
I	**Overview of Predictive Analytics** What Is Analytics? What Is Predictive Analytics? Supervised vs. Unsupervised Learning, Parametric vs. Non-Parametric Models, Business Intelligence, Predictive Analytics vs. Business Intelligence, Do Predictive Models Just State the Obvious? Similarities between Business Intelligence and Predictive Analytics, Predictive Analytics vs. Statistics, Statistics and Analytics Predictive Analytics and Statistics Contrasted, Predictive Analytics vs. Data Mining, Who Uses Predictive Analytics?, Challenges in Using Predictive Analytics, Obstacles in Management, Obstacles with Data, Obstacles with Modeling, Obstacles in Deployment. **Setting Up the Problem** Predictive Analytics Processing Steps: CRISP-DM, Business	**15**

	Understanding, The Three-Legged Stool, Business Objectives, Defining Data for Predictive Modeling, Defining the Columns as Measures, Defining the Unit of Analysis, Which Unit of Analysis?, Defining the Target Variable, Temporal Considerations for Target Variable, Defining Measures of Success for Predictive Models, Success Criteria for Classification, Success Criteria for Estimation, Doing Predictive Modeling Out of Order, Building Models First, Early Model Deployment.	
II	**Data Understanding** What the Data Looks Like, Single Variable Summaries: Mean, Standard Deviation, The Normal Distribution, Uniform Distribution, Applying Simple Statistics in Data Understanding, Skewness, Kurtosis, Rank-Ordered Statistics, Categorical Variable Assessment. Data Visualization in One Dimension: Histograms, Multiple Variable Summaries, Hidden Value in Variable Interactions: Simpson's Paradox, The Combinatorial Explosion of Interactions: Correlations, Spurious Correlations, Back to Correlations. Data Visualization, Two or Higher Dimensions: Scatterplots, Anscombe's Quartet. **Data Preparation** Variable Cleaning: Incorrect Values, Consistency in Data Formats, Outliers, Multidimensional Outliers, Missing Values, Fixing Missing Data. Feature Creation: Simple Variable Transformations, Fixing Skew, Binning Continuous Variables, Numeric Variable Scaling, Nominal Variable Transformation, Ordinal Variable Transformations, Date and Time Variable Features.	**15**
III	**Item sets and Association Rules** Terminology: Condition, Left-Hand-Side, Antecedent(s), Right-Hand-Side, Consequent, Output, Conclusion, Rule (Item Set), Support, Antecedent Support, Confidence, Accuracy, Lift, Parameter Settings. Deploying Association Rules: Variable Selection, Interaction Variable Creation, Problems with Association Rules: Redundant Rules, Too Many Rules, Too Few Rules. **Descriptive Modeling.** Data Preparation Issues with Descriptive Modeling, Principal Component Analysis: The PCA Algorithm, Applying PCA to New Data, PCA for Data Interpretation. Clustering Algorithms: The K-Means Algorithm, Data Preparation for K-Means, Selecting the Number of Clusters.	**15**
IV	**Predictive Modeling** Decision Trees: The Decision Tree Landscape, Building Decision Trees,	**15**

	Decision Tree Splitting Metrics. Logistic Regression: Interpreting Logistic Regression Models. Naïve Bayes: Bayes' Theorem, The Naïve Bayes Classifier, Interpreting Naïve Bayes Classifiers. Linear Regression: Linear Regression Assumptions, Variable Selection in Linear Regression, Interpreting Linear Regression Models, Using Linear Regression for Classification. **Text Mining** A Predictive Modeling Approach to Text Mining, Structured vs. Unstructured Data, Why Text Mining Is Hard: Text Mining Applications, Data Sources for Text Mining. Data Preparation Steps: POS Tagging, Tokens, Stop Word and Punctuation Filters, Character Length and Number Filters, Stemming.	

Text Book

1. Dean Abbott, Applied Predictive Analytics: Principles and Techniques for the professional Data Analyst, John Wiley & Sons Inc. Publishers, First edition, 2014.

Reference Books

1. Klimberg, Ron and B.D. McCullough, Fundamentals of Predictive Analytics with JMP®, Cary, NC: SAS Institute Inc., Second Edition, 2016.
2. Eric Siegel, Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die, John Wiley & Sons Inc. Publishers, Second edition, 2016.
3. Hui Yang, Eva K. Lee, Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, John Wiley & Sons Inc. Publishers, 2016.

Major (Credit 4)

Fundamentals of Deep Learning

Course Code: M24IT3MJ01 **Course Credit:04**

1 credit: 15 lectures **1 Lecture: 60minutes**

Course Objectives:

The course will enable learners to boost the knowledge of Neural Networks and Deep Learning

1. To present the mathematical, statistical and computational challenges of building neural networks
2. To study the concepts of deep learning
3. To enable the students to know deep learning techniques to support real-time applications.

Course Outcomes:

After completion of the course, a learner should be able to:

1. Describes basics of mathematical foundation to understand concepts and describe models of

Deep Learning.
2. Design and implement various deep supervised learning architectures for text & image data.
3. Design and implement various deep learning models and architectures.
4. Apply various deep learning techniques to design efficient algorithms for real-world applications.

UNIT	Topic	HRS
I	**Deep Learning basics and Linear Algebra:** Neurons Revisited, Activation Functions, Function:MSE,RMSE 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. **Numerical Computation:** Overflow and underflow, poor conditioning, Gradient Based Optimization, Constraint optimization. **Deep feedforward network :**Gradient Based Learning-Cost function,output units,Hidden Units, Architecture Design,Back propagation	15
II	**Regularization for deep learning :**L1, L2 Regularization,Dataset Augmentation, Noise Robutness,Semi-supervised and Mutitask Learning,Early Stopping, Bagging, Dropout **Optimization for Training deep models:** Challenges in Neural Network Optimization, Algorithms: Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, Algorithms with Adaptive Learning Rates: AdaGrad, RMSProp, Adam, Learning Approximate Second order Methods:Newton,Conjugate Gradient **Convolutional Neural Networks:**Kernels and Filters,Building Blocks of CNN, The Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function,Structured Outputs, Data Types,Types of Convolutional Neural Network: LeNet, AlexNet, VGG-16 Net, ResNet and Inception Net	15
III	**Sequence Modelling**: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architecture, Deep Recurrent Networks, Recursive Neural Networks, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs **Linear Factor Models:** Probabilistic PCA and Factor Analysis, Independent Component Analysis, Slow Feature Analysis, Sparse Coding **Autoencoders:** Types: Undercomplete,regularizing, Stochastic Encoders and Decoders, Denoising Autoencoders, Contractive Autoencoders	15

IV	**Deep Generative Models:** Boltzmann Machines, Restricted Boltzmann Machines,Deep Belief Network, Deep Boltzmann Machines, Directed Generative Nets **Applications of Deep Learning:** Deep Learning for Object Localization and classification: Intersect Over Union (IoU), Sliding Window Approach, Region-Based CNN (R-CNN) Deep Learning for Language Modelling and Speech Recognition	15

TEXT BOOKS:

1. Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courvile An MIT Press book 1st 2016
2. Fundamentals of Deep Learning Nikhil Buduma O'Reilly 1st 2017
3. Deep Learning: Methods and Applications Deng & Yu Now Publishers 1st 2013
4. Deep Learning CookBook Douwe Osinga O'Reilly 1st 2017
5. Advanced Deep Learning with Keras, Rowel Atienza, Packt Publication, 2018
6. Python Deep Learning Cookbook, Indra den Bakker, Packt Publication, 2017
7. Deep Learning with Keras, Antonio Gulli, Packt Publication, 2017

REFERENCE BOOKS:

1. Python Deep Learning, Valentino Zocca, Packt Publication, 2017
2. Applied Deep Learning, with TensorFlow 2, Umberto Michelucci, Apress, 2022
3. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress, 2017

Major(Credit 4)

Practicals of Introduction to Predictive Analytics and Fundamentals of Deep Learning

Course Code: M24IT3MJP03 **Course Credit: 4**

1 credit - 15 lectures

1 lecture is 120 minutes

Course Objectives:

1. To implement the fundamental concepts of predictive analytics.
2. To execute various predictive analysis models.

Course Outcomes :

1. Develop different predictive models for decision making.

2. Implement descriptive modeling techniques for the given data.

3. Assess and interpret different predictive models.

Sr.No.	Practicals of Introduction to Predictive Analytics
1	Clustering based data analytics using R/Python.(K –means algorithm)
2	Demonstrate the statistics for a sample data like mean, standard deviation, normal/uniform distribution, variance and correlation.
3	Demonstrate data visualization, histograms and multiple variable summaries.
4	Demonstrate transformation, scaling, binning, fixing skewed values and sampling.
5	Demonstrate missing value analysis, fixing missing values and outlier analysis using various domain datasets
6	a. Design a simple machine learning model (Linear Regression) to train the training instances and test the same using Python. b. Demonstrate Linear Regression model and also plot a graph showing relation between dependent(y) and independent(x) variable.
7	Write a program to implement Decision Tree Prediction. Test Score and Confusion Matrix.
8	For a given set of training data examples stored in a .CSV file implement Logistic Regression algorithm.
9	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set.
10	Demonstration of Temporal Mining Techniques

Fundamentals of Deep Learning Practical

SR. NO	Practical Topic
1	Solving XOR problem using deep feed forward network.
2	Implementing deep neural network for performing binary classification task.
3	Using a deep feed forward network with two hidden layers for performing multiclass classification and predicting the class.
4	a) Using a deep feed forward network with two hidden layers for performing classification and predicting the probability of class. b) Using a deep feed forward network with two hidden layers for performing

	linear regression and predicting values c) Evaluating feed forward deep network for regression using K-Fold cross validation d) Evaluating feed forward deep network for multiclass classification using K-Fold cross-validation.
5	Implementation of convolutional neural network to predict numbers from number image.
6	Demonstrate recurrent neural network that learns to perform sequence analysis for stock price
7	Performing encoding and decoding of images using deep Autoencoder
8	Denoising of images using Autoencoder
9	Write a program for object detection from the image/video.
10	Write a program for object detection using pre-trained models to use object detection.

Major (Credit 2)

Understanding Generative AI

COURSE CODE: M24IT3MJ04 **COURSE CREDIT: 02**

1 credit - 15 lectures 1 lecture is 60 minutes

Course Objectives:

The objectives of the Course are:

1. Understand the Fundamentals of Generative AI
2. Explain the differences between generative and discriminative models
3. Understand Ethical Considerations
4. Promote Responsible AI Practices

Course Outcomes:

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

1. Demonstrate a solid understanding of the fundamental principles and theories of generative AI, including the distinctions between various generative models.
2. Recognize and articulate the ethical considerations and societal impacts associated with generative AI, including issues of bias, privacy, and potential misuse.

Unit	Topic	Hours
I	**AI In A Nutshell**: What Is AI?, What Is Discriminative AI?, What Is Generative AI? **Innovative Approaches For High-Quality Data Generation :** Why Generative Models?, From Birth to Maturity: Tracing the Development of	15

	Generative Models, GANs: The Era of Modern Generative AI Begins, From Pixels to Perfection: The Evolution of AI Image Generation, A Crucial Tech Disruption: Text Generation, Tech Triumphs in Text Generation	
II	**Generative AI's Broad Spectrum of Applications:** Foundational and Specialized AI Models, and the Question of Open Source vs. Closed Source, Application Fields, The Untapped Potential of Generative AI **Ethical Concerns and Social Implications of Generative AI :** Intellectual Property and the Generative AI Platform, Bias and Fairness in AI-Generated Data, Misinformation and Misuse of Generative AI, Privacy, Safety, and Security, Generative AI's Impact on Jobs and Industry, The Dependency on AI, Environmental Concerns, AI Oversight and Self-Regulation, On a Positive Note	15

Books and References:

1. Generative AI, Martin Musiol, Wiley, February 2024
2. Introduction to Generative AI, Maggie Engler, Numa Dhamani, Manning Publications, February 2024
3. What Is Generative AI?, Kyle Stratis , O'Reilly Media, Inc., December 2023

Research Project (Credit 4)

COURSE CODE: M24IT3RP01 **COURSE CREDIT: 04**

1 credit - 15 lectures 1 lecture is 60 minutes

Course Objectives:

The student should:

1. To understand the recent trends in the domain of his project
2. To understand different ways of solving a problem
3. To document the Research in a scientific manner.
4. To Identify Research gaps in the domain of Interest

Course Outcome:

The student

1. Be able to apply relevant knowledge and abilities, within the main field of study, to a given problem within given constraints, even with limited information, independently
2. Analyse and discuss complex inquiries/problems and handle larger problems on the advanced level within the main field of study

Literature Review and Project Proposal

The learners are expected to develop a project beyond the undergraduate level. Normal web sites, web applications, mobile apps are not expected. Preferably, the project should be from the elective chosen by the learner at the postgraduate level. In semester three, the learner is supposed to conduct Literature Review and prepare the synopsis and documentation. The same project has to be implemented in Semester IV. A Research Paper based on the Project to be published in Semester IV.

Project Proposal/research plan

The student should spend the first 1-2 weeks writing a 1-2 pages project plan containing:
- Short background of the project
- Aims of the project
- Short description of methods that will be used
- Estimated time schedule for the project

The research plan should be handed in to the supervisor.Writing the project plan will help you plan your project work and get you started in finding
information and understanding of methods needed to perform the project.

For the master's documentation, the chapters cannot be dictated, they may vary according to the type of project. However, in Semester III Project Documentation and Viva Voce must contain at least 4 chapters (Introduction, Review of Literature, Methodology / Approach, Proposed Design / UI design, etc. depending on the type of project.) The Semester III report should be spiral bound.

Revised Scheme of Examination
Faculty of Science
(Postgraduate Programme)

SCHEME OF EXAMINATION (for 100 marks and 4 credits)

The scheme of examination shall be divided into two parts:

- **Internal assessment 40%, i.e. 40 marks**
- **Semester end examination 60%, i.e. 60 marks**

(A) Internal Assessment 40 marks

Description	Marks
An internal test of 20 marks	20
Research Paper Writing & Presentation	15
Attendance and Class Participation	5
Total	40

B) Semester End examination 60 marks

PAPER PATTERN

Duration: 2.5 hours	
Total Marks:60	
Q.1 15 marks OR 15 marks (7 and 8 marks)-Unit 1	15
Q.2 15 marks OR 15 marks (7 and 8 marks)-Unit 2	15
Q.3 15 marks OR 15 marks (7 and 8 marks)-Unit 3	15
Q.4 15 marks OR 15 marks (7 and 8 marks)-Unit 4	15
Total	60

Passing criteria: Minimum 40% in Internal (16 out of 40) and 40% (24 out of 60) in semester end examination.

SCHEME OF EXAMINATION (for 50 marks, 2 credits Theory)

The scheme of examination shall be divided into two parts:

- **Internal assessment 40% i.e.20 marks**
- **Semester end examination 60% i.e.30 marks**

(A)Internal Assessment 40 marks

Description	Marks
An internal test of 10 marks	10
Case Study/ Assignment	05
Attendance and Class Participation	05
Total	20

B) Semester End examination 30 marks

PAPER PATTERN

Duration: 1.25 hour	
Total Marks:30	
Q.1 15 marks OR 15 marks (7 and 8 marks)-Unit 1	15
Q.2 15 marks OR 15 marks (7 and 8 marks)-Unit 2	15
Total	30

Passing criteria: Minimum 40% in Internal (08 out of 20) and 40% (12 out of 30) in semester-end examination.

SCHEME OF PRACTICAL EXAMINATION (for 50 marks , 2 credits)

The scheme of examination shall be divided into two parts:

- **Internal assessment 40% i.e.20 marks**
- **Semester end examination 60% i.e.30 marks**

(A)Internal Assessment 20 marks

Description	**Marks**
Practical Internal Assessment	10
Viva	05
Journal	05
Total	20

B) Semester end examination 30 marks

PAPER PATTERN

Duration: 1.5 hours	
Total Marks:30	
Q.1 Practical Q1	15
Q.2 Practical Q2	15
Total	30

Passing criteria: Minimum 40% in Internal (08 out of 20) and 40% (12 out of 30) in the semester-end examination.

Elective(Credit 4)

SWAYAM (Advanced Course) of minimum 20 hours certification exam completed – 100 Marks

OR

NPTEL (Advanced Course) of minimum 20 hours and certification exam completed - 100 Marks

- **Internal Evaluation (40 Marks)**
  Assignments
- **External Evaluation (60 Marks)**
  Certification exam

Project Documentation and Viva Voce Evaluation

The documentation should be checked for plagiarism, and as per UGC guidelines, it should be less than 10%.

1	Documentation Report (Chapter 1 to 4)	30
2	Literature Review	30
3	Innovation in the topic	10
4	Documentation/Topic presentation and viva voce	20
5	Relevance to Social Cause	10

Passing Standard

The learners to pass a course shall have to obtain a minimum of 40% marks in each head of passing, consisting of Internal Assessment and Semester End Examination. The learners shall obtain a minimum of 40% marks (i.e. 16 out of 40 or 8 Out of 20) in the Internal Assessment and 40% marks in the Semester End Examination (i.e. 24 Out of 60 or 12 Out of 30) separately, to pass the course and a minimum of Grade D, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

AC: 29.06.2024
Item No.: 1.2.3

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RISE WITH EDUCATION

CELEBRATING 25 YEARS 1998-2023

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3	Minimum Percentage for admission	40%
4	Passing Marks	40%
5	Semesters	IV
6	Level	PG
7	Pattern	1-2 years & 2-4 semesters Choice Based Grading System
8	Status	New
9	To be implemented from	From Academic year 2024-25 in a progressive manner

Date: 29.06.2024
Signature:

COLLEGE OF ARTS, SCIENCE AND COMMERCE (AUTONOMOUS) NERUL NAVI MUMBAI 400 706.

Dr. Koel Roychoudhury
AC Chairperson

Dr.Anu Thomas
Head of the Department

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SIES (Nerul) College of Arts, Science and Commerce (Autonomous)
(Affiliated to University of Mumbai)
RE-ACCREDITED GRADE "A" BY NAAC (3rd CYCLE)

BOARD OF STUDIES
SYLLABUS FOR
M.Sc (Information Technology)

(WITH EFFECT FROM THE ACADEMIC YEAR 2024-2025)

OBJECTIVES OF THE PROGRAMME:

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- Ability to provide socially acceptable technical solutions in the domains of Information Security, Machine Learning, Infrastructure Services as specializations.
- Ability to apply the knowledge of Intellectual Property Rights and Cyber Forensics and various standards in interest of National Security and Integrity along with IT Industry.
- Ability to write effective project reports, research publications and content development and to work in a multidisciplinary environment in the context of changing technologies.

M.Sc. Information Technology Programme

(To be implemented from Academic Year- 2024-25)

No. of Courses	Course Code	Semester IV	Credits
1	Major		
1	M24IT4MJ01	Blockchain Technologies	4
2	M24IT4MJ02	Reinforcement Learning	4
3	M24IT4PMJ03	Practical of Blockchain Technologies and Reinforcement Learning	4
2	Electives(E) Electives to be done from NPTEL Repository.		
4	M24IT4E01	Advanced Natural Language Processing	4
	M24IT4E02	Ethical Hacking	
3	M24IT4RP01	Research Project	6
Total Credits			22

Semester IV
Major (Credit 4)

Blockchain Technologies

COURSE CODE: M24IT4MJ01 **COURSE CREDIT: 04**

1 credit - 15 lectures 1 lecture is 60 minutes

Course Objectives:

The objectives of the Course are:

1. To provide conceptual understanding of the function of Blockchain as a method of securing distributed ledgers, how consensus on their contents is achieved, and the new applications that they enable.
2. To cover the technological underpinnings of blockchain operations as distributed data structures and decision-making systems, their functionality and different architecture types.
3. To provide a critical evaluation of existing "smart contract" capabilities and platforms, and examine their future directions, opportunities, risks and challenges

Course Outcomes:

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

1. The students would understand the structure of a blockchain and why/when it is better than a simple distributed database.
2. Analyze the incentive structure in a blockchain based system and critically assess its functions, benefits and vulnerabilities
3. Evaluate the setting where a blockchain based structure may be applied, its potential and its limitations
4. Understand what constitutes a "smart" contract, what are its legal implications and what it can and cannot do, now and in the near future
5. Delve into emerging trends like decentralized and self-sovereign identity, DeFi, NFTs, and Metaverse

Unit	Topic	Hours
I	**Blockchain 101:** The growth of blockchain technology, Distributed systems, Introducing blockchain, Types of blockchain **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

II	**Bitcoin Architecture:** Introducing Bitcoin, Cryptographic keys, Addresses, Transactions, Blockchain, Miners, Network, Wallets **Ethereum:** Ethereum Architecture, Introducing Ethereum, Cryptocurrency, Keys and addresses, Accounts, Transactions and messages, Ethereum virtual machine, Blocks and blockchain, Nodes and miners, The Ethereum network, Precompiled smart contracts, Wallets and client software, Supporting protocols	15
III	**Tools, Languages, and Frameworks for Ethereum Developers:** Languages, The Solidity compiler, Tools, libraries, and frameworks, Contract development and deployment, The Solidity language **The Merge and Beyond:** Introduction, Ethereum after The Merge, The Merge, Sharding, The future roadmap of Ethereum **Hyperledger:** Projects under Hyperledger, Hyperledger reference architecture, Hyperledger Fabric, Fabric 2.0	15
IV	**Tokenization:**Tokenization on a blockchain, Types of tokens, Process of tokenization, Token offerings,Token standards, Emerging concepts **Blockchain Privacy**: Privacy,Techniques to achieve privacy, Example **Blockchain Security**: Blockchain Security, Security, Blockchain layers and attacks, Attacks on layer 2 blockchains, Security analysis tools and mechanism, Threat modelling, Regulation and compliance	15

Books and References:

1. Mastering Blockchain - Fourth Edition, Imran Bashir, Packt Publishing, March 2023
2. The Essential Guide to Web3, Vijay Krishnan, Packt Publishing, November 2023
3. Beginning Blockchain - A Beginner's Guide to Building Blockchain Solutions, Bikramaditya Singhal, Gautam Dhameja and Priyansu Sekhar Panda, Apress,2018

Major (Credit 4)

Reinforcement Learning

COURSE CODE: M24IT4MJ02 **COURSE CREDIT: 04**

1 credit - 15 lectures **1 lecture is 60 minutes**

Course Objective:

1. Grasp the core building blocks of RL (agent, environment, etc.) and its real-world applications.
2. Master the Bellman Equations for solving RL problems in controlled settings.
3. Understand Q-Learning, a key algorithm for making optimal decisions in RL.
4. Gain a foundation in policy gradient methods for optimizing RL policies.

Course Outcome:

Students can

1. Define RL, its components, and applications (robotics, resource management etc.).
2. Use Bellman Equations for optimal policies in controlled environments.
3. Explain and implement Q-Learning for optimal decision-making.
4. Understand policy gradients and implement a basic algorithm

Unit	Topic	Hours
I	**Introduction:** Machine Learning Techniques, Introduction and Basic of Reinforcement Learning, Examples, Elements of Reinforcement Learning, Limitations and Scope, An Extended Example: Tic-Tac-Toe **Markov Decision Process (MDP):** Markov Process, Markov Reward Process, Return and Episodes, policies and value function, Markov Decision Process and Bellman Equations, Partially Observable MDPs. **Planning by Dynamic Programming (DP):** Policy Evaluation, policy improvement, Value Iteration, Policy Iteration, Asynchronous Dynamic programming, Generalized policy iteration, efficiency of dynamic programming	15
II	**Model-free Prediction:** **Monte-Carlo (MC) Learning:** Monte Carlo Methods, Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, off-policy Prediction via Importance Sampling, Incremental Implementation, and off-policy Monte Carlo Control. **Temporal-Difference (TD) Learning:** TD Prediction, Advantages of TD Prediction Methods, Optimality of TD(0), Sarsa: On-policy TD Control, Q-learning: Off-policy TD Control, Expected Sarsa, Maximization Bias and Double Learning **Eligibility Traces:** The λ return, TD(λ), n-step Truncated λ-return Methods, Redoing Updates: Online λ-return Algorithm, True Online TD(λ), Sarsa(λ), Variable λ and Υ, off policy Traces with Control Variates, Watkins's Q(λ) to Tree-Backup(λ), Stable Off-policy Methods with Traces	15
III	**Model-free Control:** **On-policy Control:** Episodic Semi-gradient Control, Semi-gradient n-step Sarsa, Average Reward: A New Problem Setting for Continuing Tasks, Deprecating the Discounted Setting, Differential Semi-gradient n-step Sarsa. **Off-policy Methods:** Semi-gradient Methods, Examples of Off-policy Divergence, The Deadly Triad, Linear Value-function Geometry, Gradient Descent in the Bellman Error, The Bellman Error is Not Learnable, Gradient-TD Methods, Emphatic-TD Methods, Reducing Variance	

	On-policy Prediction with Approximation: Value-function Approximation, The Prediction Objective (VE), Stochastic-gradient and Semi-gradient Methods, Linear Methods, Feature Construction for Linear Methods, Selecting Step-Size Parameters Manually, Nonlinear Function Approximation: Artificial Neural Networks, Least-Squares TD, Memory-based Function Approximation, Kernel-based Function Approximation	15
IV	**Policy Gradient Methods:** Policy Approximation and its Advantages, The Policy Gradient Theorem, REINFORCE: Monte Carlo Policy Gradient, REINFORCE with Baseline, Actor–critic Methods **Integrating Planning with Learning:** Models and Planning, Dyna: Integrated Planning, Acting, and Learning, When the Model Is Wrong, Prioritized Sweeping, Expected vs. Sample Updates, Trajectory Sampling, Real-time Dynamic Programming, Planning at Decision Time, Heuristic Search, Rollout Algorithms, Monte Carlo Tree Search **Exploration and Exploitation (Bandits):** A K-armed Bandit Problem, Action-value Methods, The 10-armed Testbed, Incremental Implementation, Tracking a Nonstationary Problem, Optimistic Initial Values, Upper-Confidence-Bound Action Selection, Gradient Bandit Algorithms, Associative Search (Contextual Bandits)	15

References

1. Richard S. Sutton and Andrew G. Barto; Reinforcement Learning: An Introduction; 2nd Edition, MIT Press, 2020.
2. Csaba Szepesvári; Algorithms of Reinforcement Learning; Synthesis Lectures on Artificial Intelligence and Machine Learning, vol. 4, no. 1, 2010.
3. Dimitri P. Bertsekas; Reinforcement Learning and Optimal Control; 1st Edition, Athena Scientific, 2019.
4. Dimitri P. Bertsekas; Dynamic Programming and Optimal Control (Vol. I and Vol. II); 4th Edition, Athena Scientific, 2017.
5. Andrew G. Barto and Sridhar Mahadevan; Recent Advances in Hierarchical Reinforcement Learning; Discrete Event Dynamic Systems, vol. 13, pp. 341–379, 2003.
6. Thomas G. Dietterich; Hierarchical Reinforcement Learning with the MAXQ Value Function Decomposition; Journal of Artificial Intelligence Research, vol. 13, pp. 227-303, 2000.

Online Courses:

- https://cs224r.stanford.edu/
- https://deepmind.google/
- https://www.youtube.com/watch?v=M-1g_BU0gjY

Major(Credit 4)

Practical of Blockchain Technologies and Reinforcement Learning

COURSE CODE: M24IT4MJ03 **COURSE CREDIT: 04**

1 credit - 15 lectures **1 lecture is 60 minutes**

Practicals

Course Objectives:

1. To provide practical understanding of the working of Blockchain as a method of securing distributed ledgers, how consensus on their contents is achieved, and the new applications that they enable.
2. To provide hands-on knowledge of the Solidity programming language
3. To provide an overview of existing technologies for Blockchain Programming
4. Apply different concepts of Reinforcement learning, such as Value Iteration, Monte carlo, SARSA etc.

Course Outcomes:

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

1. The students would understand the working of a blockchain.
2. Analyze the different concepts in the background of a working blockchain for solving real world problems
3. Develop applications based on blockchain for creating enterprise solutions.
4. Implement different concepts of Reinforcement learning Value Iteration, Monte carlo, SARSA etc.

Sr.No	List of Practicals-Blockchain
1	Demonstrate Blockchain consensus - PoW using Python a. A simple client class that generates the private and public keys by using the built-in Python RSA algorithm and test it. b. b. A transaction class to send and receive money and test it. c. Create multiple transactions and display them. d. Create a blockchain, a genesis block and execute it. e. Create a mining function and test it. f. Add blocks to the miner and dump the blockchain.
2	Solidity Language: Variable, Operators, Loops, Decision Making, Strings, Arrays, Mappings
3	Solidity Language: Functions, Function Modifiers, View functions, Pure Functions, Fallback Function, Function Overloading

4	Solidity Language: Contracts, Inheritance, Constructors, Abstract Contracts, Interfaces
5	Demonstrate the use of Metamask Wallet 1. Funding the Wallet 2. Creating and using a Custom Token 3. Executing Smart Contracts
6	Demonstrate Web3 Development Using Ethereum.
7	Demonstrate the steps in Building an ERC-20 token.
8	Create your own Blockchain in Node.js and demonstrate its Use.
9	Demonstrate the running of the Blockchain Nodes.
10	Demonstrate the use of IPFS

Sr. No.	List of Practicals-RL
1	Write a program to train a Robot to Walk.
2	Write a program to build a video game bot that plays a car racing game.
3	Write a program to implement the Frozen Lake Problem Using Value Iteration
4	Write a program to solve the Frozen Lake Problem Using Policy Iteration
5	Write a program to estimate the Value of Pi using Monte Carlo
6	Write a program to solve the Taxi Problem using Q Learning
7	Write a program to solve the Taxi Problem Using SARSA
8	Write a program to implement the Multi-Armed Bandit Problem
9	Write a program to identify the Right AD Banner Using MAB.
10	Write a program to implement the Actor-Critic Method in Reinforcement Learning.

Research Project (Credit 6)

COURSE CODE: M23IT1RP01 **COURSE CREDIT: 06**

1 credit - 15 lectures **1 lecture is 60 minutes**

Course Objectives:

The student should:

1. Be able Reflect on, evaluate and critically review one's own and others' scientific results
2. Be able to document and present one's own work with strict requirements on structure, format, and language usage
3. Be able to identify one's need for further knowledge and continuously develop one's own knowledge

Course Outcome:

On successful completion of the course, the learner will be able to:

1. Identify the Solve real world problems.
2. Apply relevant knowledge and abilities, within the main field of study, to a given problem within given constraints, even with limited information, independently
3. Analyse and discuss complex inquiries/problems and handle larger problems on the advanced level within the main field of study

The credits for this paper will be distributed in the following manner:
Research Paper Publication -02 Credits
Research Project Implementation-04 Credits

Research Paper Publication

A quality research paper should be written under the guidance of the faculty. The paper is expected to be published in Peer-Reviewed, UGC Care Listed, Scopus, Web of Science, IEEE and the like journals. Plagiarism should be less than 10%.

Research Project Implementation

The Semester IV documentation should be a continuation of Semester -3 Documentation. The Chapters should include Experiments performed, Results and discussion, Conclusions and proposals for future work, Appendices and Bibliography - references and links. Semester IV report should include all the chapters and should be hardbound.
Guidelines for Documentation of Project Proposal in Semester –IV

A Student should submit project implementation report with following details:

- Title: Title of the project (Same as the one proposed and evaluated at the semester II examination).
- Implementation details: A description of how the project has been implemented. It shall be of 2 to 4 pages.
- Experimental set up and results: A detailed explanation on how experiments were conducted, what software used and the results obtained. Student can add details like screenshots, tables and graphs. It shall be of 6 to 10 pages.

- Analysis of the results: A description on what the results means and how they have been arrived at. Different performing measures or statistical tools used etc may be part of this. It shall be of 4 to 6 pages.
- Conclusion: A conclusion of the project performed in terms of its outcome (May be half a page).
- Future enhancement: A small description on what enhancement can be done when more time and resources are available (May be half a page).
- Program code: The program code may be given as appendix. The proposal may be of around 20 pages (excluding program code), which needs to be signed by the teacher in charge and head of the Department.

Complete Project report of around 100 pages should be submitted.

Revised Scheme of Examination
Faculty of Science
(Postgraduate Programme)

SCHEME OF EXAMINATION (for 100 marks and 4 credits)

The scheme of examination shall be divided into two parts:

- **Internal assessment 40%, i.e. 40 marks**
- **Semester end examination 60%, i.e. 60 marks**

(A) Internal Assessment 40 marks

Description	Marks
An internal test of 20 marks	20
Research Paper Writing & Presentation	15
Attendance and Class Participation	5
Total	40

B) Semester End examination 60 marks

PAPER PATTERN

Duration: 2.5 hours	
Total Marks:60	
Q.1 15 marks OR 15 marks (7 and 8 marks)-Unit 1	15
Q.2 15 marks OR 15 marks (7 and 8 marks)-Unit 2	15
Q.3 15 marks OR 15 marks (7 and 8 marks)-Unit 3	15
Q.4 15 marks OR 15 marks (7 and 8 marks)-Unit 4	15
Total	60

Passing criteria: Minimum 40% in Internal (16 out of 40) and 40% (24 out of 60) in semester end examination.

SCHEME OF EXAMINATION (for 50 marks, 2 credits Thcory)

The scheme of examination shall be divided into two parts:

- **Internal assessment 40% i.e.20 marks**
- **Semester end examination 60% i.e.30 marks**

(A)Internal Assessment 40 marks

Description	Marks
An internal test of 10 marks	10
Case Study/ Assignment	05
Attendance and Class Participation	05
Total	20

B) Semester End examination 30 marks

PAPER PATTERN

Duration: 1.25 hour	
Total Marks:30	
Q.1 15 marks OR 15 marks (7 and 8 marks)-Unit 1	15
Q.2 15 marks OR 15 marks (7 and 8 marks)-Unit 2	15
Total	30

Passing criteria: Minimum 40% in Internal (08 out of 20) and 40% (12 out of 30) in semester-end examination.

SCHEME OF PRACTICAL EXAMINATION (for 50 marks , 2 credits)

The scheme of examination shall be divided into two parts:

- **Internal assessment 40% i.e.20 marks**
- **Semester end examination 60% i.e.30 marks**

(A)Internal Assessment 20 marks

Description	**Marks**
Practical Internal Assessment	10
Viva	05
Journal	05
Total	20

B) Semester end examination 30 marks

PAPER PATTERN

Duration: 1.5 hours	
Total Marks:30	
Q.1 Practical Q1	15
Q.2 Practical Q2	15
Total	30

Passing criteria: Minimum 40% in Internal (08 out of 20) and 40% (12 out of 30) in the semester-end examination.

Elective(Credit 4)

SWAYAM (Advanced Course) of minimum 20 hours certification exam completed – 100 Marks

OR

NPTEL (Advanced Course) of minimum 20 hours and certification exam completed - 100 Marks

- **Internal Evaluation (40 Marks)**
  Assignments
- **External Evaluation (60 Marks)**
  Certification exam

Project Implementation and Viva Voce Evaluation

1	Documentation Report (Chapter 5 to last)	30
2	Implementation	30
3	Relevance of the topic	10
4	Presentation	10
5	Viva Voce	20
6	Published Research Paper	50

Passing Standard

The learners to pass a course shall have to obtain a minimum of 40% marks in each head of passing, consisting of Internal Assessment and Semester End Examination. The learners shall obtain a minimum of 40% marks (i.e. 16 out of 40 or 8 Out of 20) in the Internal Assessment and 40% marks in the Semester End Examination (i.e. 24 Out of 60 or 12 Out of 30) separately, to pass the course and a minimum of Grade D, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.