R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri

Master of Science (M.Sc) Programme
Two Year Integrated Programme

Four Semesters

Course: Computer Science

Syllabus for MSc Semester I & II

Under Choice Based Credit System (CBCS)

To be implemented from Academic Year- 2023-2024

Preamble

The Master of Science in Computer Science (M.Sc. Computer Science) is an advanced program that combines academic research and industry standards, addressing the evolving needs of both the industry and research domains. The curriculum focuses on cutting-edge technologies and industry insights, ensuring students gain the necessary expertise to thrive in the current landscape.

Throughout this program, students will delve into a wide range of relevant subjects. In first year, they study subjects including Machine Learning, Image Processing, Networking, Blockchain, Cloud Computing, Big Data, Computer and Network Security, Web Data Mining, and Simulation and Modeling. In the M.Sc second year program, students will engage with major mandatory subjects such as Web3 Technologies, Cyber Security and Risk Assessment, Ethical & Responsible AI, Deep Learning, and Big Data Analytics. They can also choose from major elective subjects like Social Network Analysis or Data Visualization or Fuzzy Systems, as well as Trends in Cloud Computing or Remote Sensing or Server Virtualization. Research projects in both semesters provide practical experience and foster critical skills. This comprehensive curriculum equips students with the latest knowledge and prepares them for diverse opportunities in computer science. Being as an Autonomous College, these courses are carefully designed to equip students with the skills required to tackle the challenges and opportunities in the rapidly expanding field of Computer Science to compete with other autonomous colleges and University affiliated Colleges. The program is structured as a fusion of Major Mandatory and Major Elective courses, encompassing the latest trends and advancements in Computer Science. In each semester, students have the opportunity to choose one elective subject aligned with their interests from a selection of three options. The Major Mandatory courses establish a strong foundation in fundamental concepts of Computer Science and Research, while the electives enhance their knowledge for real-world applications. Practical implementation is facilitated through the use of industry-standard tools and simulators, such as Cisco for networking and Python for programming.

To further enhance the students; readiness for industry, the curriculum incorporates a mandatory On Job Training (OJT) component in Semester II. This intensive training, equivalent to a full course, provides invaluable exposure to real-world scenarios within IT or IT-related organizations. By applying their theoretical knowledge in practical settings, students gain first-hand experience and develop the necessary skills to thrive in the professional world. In addition to technical skills, this program also focuses on cultivating research ethics and promoting a research-oriented mindset among learners. The inclusion of a Research Methodology Course helps students develop a strong research attitude, enabling them to contribute meaningfully to the advancement of Computer Science. The comprehensive education provided by the M.Sc. in Computer Science program equips students with the confidence to adapt and excel in an ever-evolving industry and academic landscape. The curriculum continuous refinement has been made possible through the valuable inputs, suggestions, and observations of colleagues at the University of Mumbai, experts from premier institutions, and industry professionals. We extend our gratitude to all those who have directly or indirectly contributed to the development of this program. With

these combined efforts, the M.Sc. in Computer Science program aims to empower students with the skills and knowledge necessary to thrive in the digital world.

Name of Programme	**Masters of Science**
Level	PG
No of Semesters	04
Year of Implementation	**2023-24**
Programme Specific Outcomes (PSO)	At the end of the Programme, Learner will be able to 1. Develop a solid foundation in fundamental concepts, theories, and methodologies of Computer Science. 2. Offer opportunities for specialization in a chosen area of Computer Science. 3. Foster a research-oriented mindset and contribute to the advancement of Computer Science. 4. Prepare learners for lifelong learning, adapting to emerging technologies and industry requirements. 5. Inculcate professional attitudes, leadership qualities, and social responsibility. 6. Equip students with industry-relevant skills and experiences for successful careers. 7. Enhance critical thinking and innovative problem-solving abilities.
Relevance of PSOs to the local, regional, national, and global developmental needs	1. **Provide In-depth Knowledge:** The program aims to provide students with a comprehensive understanding of the key concepts, theories, and methodologies in Computer Science. It covers a range of topics including machine learning, data mining, data visualization, and data management, enabling students to develop a deep knowledge base in these areas. 2. **Develop Programming Skills:** The program aims to equip students with strong programming skills by providing hands-on experience with different tools and technologies. Students will gain proficiency in designing front-end and back-end solutions, enhancing their ability to develop robust and scalable applications. 3. **Foster Problem-solving Abilities:** The program aims to enhance students' problem-solving abilities by training them to approach real-world data challenges critically and creatively. Students will learn to identify problems, design appropriate data analysis strategies, and develop innovative solutions using their knowledge of Computer Science. 4. **Encourage Collaboration and Teamwork:** The program aims to foster collaboration and teamwork skills among students, recognizing that computer science projects often require interdisciplinary collaboration. Students will learn to effectively

	communicate, collaborate, and contribute as part of a team, preparing them for collaborative work environments.
	5. **Foster Industry Relevance:** The program aims to stay up-to-date with industry trends and technologies to ensure graduates are well-prepared for the demands of the Computer Science job market. Through industry partnerships and internships, students will have the opportunity to gain practical experience and stay in touch with the latest advancements in the field.
	6. **Professional Development:** The program aims to prepare students for successful careers in the field of Computer Science. In addition to technical skills, students will develop professional skills such as teamwork, project management, and leadership. The program may also provide networking opportunities, internships, or collaborations with industry partners to enhance students' industry readiness and employability.
	7. **Cultivate Research Skills**: The program aims to cultivate research skills among students by providing a Research Methodology Course and encouraging participation in research projects. Students will learn to conduct literature reviews, design experiments, analyze data, and present their findings, fostering a research-oriented mindset and contributing to the advancement of Computer Science.

Master of Science (M.Sc) Programme
Under Choice Based Credit System (CBCS) Course Structure

M.Sc. I

(To be implemented from Academic Year 2023-24)

No. of Courses	Semester I	Credits	No. of Courses	Semester II	Credits
	Major Mandatory			Major Mandatory	
1	Applied Signal & Image Processing	4	1	Machine Learning	4
2	Applied Signal & Image Processing Practical	2	2	Machine Learning Practical	2
3	Software Defined Networking	4	3	Natural Language Processing	4
4	Software Defined Networking Practical	2	4	Natural Language Processing Practical	2
5	Principles of Compiler Design	2	5	Simulation and Modeling	2
	Major Electives			Major Electives	
6	NoSQL Technologies	4	6	Bioinformatics	4
	Robotic			Embedded and IoT Technology	
	UI/UX Design			Web Data Analytics	
7	Research Methodology	4	7	On Job Training/ Field Project	4
Total Credits		22	Total Credits		22

No. of Courses	Semester I	Credits
	Major : Mandatory	
PSCS101	Applied Signal & Image Processing	4
PSCS102	Applied Signal & Image Processing Practical	2
PSCS103	Software Defined Networking	4
PSCS104	Software Defined Networking Practical	2
PSCS105	Principles of Compiler Design	2
	Major : Elective (Any One from below)	
PSCS106	NoSQL Technologies	4
PSCS107	Robotic	
PSCS108	UI/UX Design	
PSCS109	Research Methodology	4
Total Credits		22

*Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I
with Effect from the Academic Year 2023-2024*

Name of the Course	Applied Signal and Image Processing
Course Code	PSCS101
Class	M. Sc. Computer Science
Semester	I
No of Credits	4
Nature	Theory
Type	Major Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	The Subject is specifically focusing on the concept of Image Processing Techniques. Employability in image processing can be quite promising, as this field is integral to various industries, including computer vision, medical imaging, remote sensing, entertainment, and more.

Applied Signal and Image Processing

Modules at glance

Sr. No.	Modules	No. of Lectures
1	Fundamentals of Digital Signals Processing	15
2	Image Processing fundamentals and Pixel-Transformation	15
3	Structural and Morphological Operations	15
4	Advanced Image Processing Operations	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to
1. Understand and apply the fundamentals of digital signal processing and frequency domain operations for image analysis.
2. Gain proficiency in image processing techniques such as intensity transformations, histogram processing, and Image derivatives.
3. Develop skills in edge detection, image segmentation, morphological operations and using various algorithms and approaches.
4. Apply advanced image processing techniques including feature detection, descriptors, and segmentation algorithms for complex image analysis and understanding..

Curriculum:

Sr. No.	Modules / Units
1	Fundamentals of Digital Signals Processing (15 Hours)
	Signals: Periodic signals, Spectral decomposition, Signals, Reading and writing Waves, Spectrums, Wave objects, Signal objects , **Noise**: Uncorrelated noise, Integrated spectrum, Brownian noise, Pink Noise, Gaussian noise; **Autocorrelation**: Correlation, Serial correlation, Autocorrelation, Autocorrelation of periodic signals, Correlation as a dot product **Frequency domain Operations**: Representing Image as Signals, Sampling and Fourier Transforms, Discrete Fourier Transform, Convolution and Frequency Domain Filtering, Smoothing using lowpass filters, Sharpening using high-pass filters. Fast Fourier Transforms.
2	Image Processing fundamentals and Pixel-Transformation (15 Hours)
	Image Processing: Definition, Application of Image Processing, Image Processing Pipeline, Tools and Libraries for Image Processing, Image types and files formats. **Intensity Transformations**- Log Transform, Power-law Transform, Contrast Stretching, Thresholding **Histogram Processing**- Histogram Equalization and Histogram Matching; Linear and Non-linear smoothing of Images, Sharpening of images **Image Derivative**: Derivatives and gradients, Laplacian, the effect of noise on gradient computation
3	Structural and Morphological Operations (15 Hours)
	Edge Detection: Sobel, Canny Prewitt, Robert edge detection techniques, LoG and DoG filters, Image Pyramids: Gaussian Pyramid, Laplacian pyramid **Morphological Image Processing**: Erosion, Dilation, Opening and closing, Hit-or-Miss Transformation, Skeletonizing, Computing the convex hull, removing small objects, White and black top- hats, Extracting the boundary, Grayscale operations
4	Advanced Image Processing Operations (15 Hours)
	Extracting Image Features and Descriptors: Feature detector versus descriptors, Boundary Processing and feature descriptor, Principal Components, Harris Corner Detector, Blob detector, Histogram of Oriented Gradients, Scale-invariant feature transforms, Haar-like features **Image Segmentation**: Hough Transform for detecting lines and circles, Thresholding and Otsu's segmentation, Edge-based/region based segmentation Region growing, Region splitting and Merging, Watershed algorithm, Active Contours, morphological snakes, and GrabCut algorithms

Learning Resources recommended:

A] Books and Textbooks:

1. Digital Image Processing by Rafael Gonzalez & Richard Woods, Pearson; 4th edition, 2018
2. Think DSP: Digital Signal Processing in Python by Allen Downey, O'Reilly Media; 1st edition (August 16, 2016)
3. Understanding Digital Image Processing, Vipin Tyagi, CRC Press, 2018
4. Digital Signal and Image Processing by Tamal Bose, John Wiley 2010
5. Hands-On Image Processing with Python by Sandipan Dey,Packt Publishing, 2018
6. Fundamentals of Digital Images Processing by A K Jain, Pearson, 2010

***Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I
with Effect from the Academic Year 2023-2024***

Name of the Course	Applied Signal and Image Processing Practical
Course Code	PSCS102
Class	M. Sc. Computer Science
Semester	I
No of Credits	2
Nature	Practical
Type	Major Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	The subject is highly useful for signal processing and image processing practical implementation. The python and concern libraries are used which gives overview of recent trends and technologies. The Subject is specifically focusing on the concept of Image Processing Techniques

Course Outcomes:
- Demonstrate upsampling, downsampling, and FFT for analyzing signals.
- Create triangle signals, compute correlations between segments, and plot signal segments.
- Implement convolution operations, template matching, and image derivatives for analysis.
- Perform log, power-law, contrast adjustments, histogram equalization, and thresholding on images.
- Apply gradient, Laplacian, and noise smoothing techniques to enhance image features.
- Utilize Sobel, Canny, and morphological operations for edge detection and region-based segmentation.

Curriculum:

Course Code	Course Title	Credits
PSCS102	**Applied Signal and Image Processing Practical**	**02**
Note: - The following set of practical should be implemented in Scrape, python: **Link: -Python: https://www.python.org/downloads/** **Minimum 8 Practicals should be submitted as Journal Work.**		
1	Write program to demonstrate the following aspects of signal processing on suitable data 1. Upsampling and downsampling on Image/speech signal 2. Fast Fourier Transform to compute DFT	
2	Write program to perform the following on signal 1. Create a triangle signal and plot a 3-period segment. 2. For a given signal, plot the segment and compute the correlation between them.	

3	Write program to demonstrate the following aspects of signal on sound/image data 1. Convolution operation 2. Template Matching
4	Write program to implement point/pixel intensity transformations such as 1. Log and Power-law transformations 2. Contrast adjustments 3. Histogram equalization 4. Thresholding, and halftoning operations
5	Write a program to apply various enhancements on images using image derivatives by implementing Gradient and Laplacian operations.
6	Write a program to implement linear and nonlinear noise smoothing on suitable image or sound signal.
7	Write a program to apply various image enhancement using image derivatives by implementing smoothing, sharpening, and unsharp masking filters for generating suitable images for specific application requirements
8	Write a program to Apply edge detection techniques such as Sobel and Canny to extract meaningful information from the given image samples
9	Write the program to implement various morphological image processing techniques.
10	Write the program to extract image features by implementing methods like corner and blob detectors, HoG and Haar features
11	Write the program to apply segmentation for detecting lines, circles, and other shapes/ objects. Also, implement edge-based and region-based segmentation.

Learning Resources recommended:

A] Books and Textbooks:

1. Digital Image Processing by Rafael Gonzalez & Richard Woods, Pearson; 4th edition, 2018
2. Think DSP: Digital Signal Processing in Python by Allen Downey, O'Reilly Media; 1st edition (August 16, 2016)
3. Understanding Digital Image Processing, Vipin Tyagi, CRC Press, 2018
4. Digital Signal and Image Processing by Tamal Bose, John Wiley 2010
5. Hands-On Image Processing with Python by Sandipan Dey,Packt Publishing, 2018
6. Fundamentals of Digital Images Processing by A K Jain, Pearson, 2010

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I

with Effect from the Academic Year 2023-2024

Name of the Course	Software Defined Networking
Course Code	PSCS103
Class	M. Sc. Computer Science
Semester	I
No of Credits	4
Nature	Theory
Type	Major Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	This course talks about the concepts of Modern networking and its implementation. It gives a broad overview about modern networking. SDN is a technology that is transforming the way networks are managed and operated. SDN allows for more flexible, programmable, and efficient network infrastructure, making it highly relevant in today's digital age

Software Defined Networking

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Introduction to Computer Networking	15
2	Software Defined Networking	15
3	Network Functions Virtualization	15
4	Design and implementation of Network	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Understand computer networking concepts, OSI/TCP-IP models, and routing protocols.
2. Gain knowledge and skills in Software Defined Networking (SDN) architecture, Open Flow, and application development.
3. Comprehend Network Functions Virtualization (NFV), cloud computing, and IoT integration in modern network architectures.
4. Develop network design and deployment skills for efficient and secure routing, traffic management, and integration of network components

Curriculum:

Sr. No.	Modules / Units
1	Introduction to Computer Networking (15 Hours)
	Basic Concepts and Definitions: LAN, MAN, WAN, AD-Hoc, Wireless Network, Understanding the layered architecture of OSI/RM and TCP-IPModel, Concepts and implementation of IPV4 and IPV6, Study of various network Routing protocols, Introduction to Transport layer and Application layer protocols
2	Software Defined Networking (15 Hours)
	Elements of Modern Networking, Requirements and Technology, SDN: Background and Motivation, SDN Data Plane and OpenFlow, SDN Control Plane, SDN Application Plane
3	Network Functions Virtualization (15 Hours)
	Concepts and Architecture, NFV Functionality, Network Virtualization Quality of Service, Modern Network Architecture: Clouds and Fog, Cloud Computing, The Internet of Things: Components
4	Design and implementation of Network (15 Hours)
	Understand and implement Layer 2/3 switching techniques (VLAN /TRUNKING/ Managing Spanning Tree), Implementation of OSPF V2 and V3, Implementation BGP, Implementation Multicast Routing, Implementation of MPLS, Implementation of Traffic Filtering by using Standard and Extended Access Control List, Implementation of Routing redistribution, Implementation

Learning Resources recommended:

A] Books and Textbooks:

1. TCPIP Protocol Suite, Behrouz A Forouzan , McGraw Hill Education; 4th edition, Fourth Edition, 2017
2. Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, William Stallings, Addison-Wesley Professional, 2016.
3. Software Defined Networks: A Comprehensive Approach, Paul Goransson and Chuck Black, Morgan Kaufmann Publications, 2014
4. SDN - Software Defined Networks by Thomas D. Nadeu & Ken Gray, O'Reilly, 2013

***Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I
with Effect from the Academic Year 2023-2024***

Name of the Course	Software Defined Networking Practical
Course Code	PSCS104
Class	M. Sc. Computer Science
Semester	I
No of Credits	2
Nature	Practical
Type	Major Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	SDN is a technology that is transforming the way networks are managed and operated. SDN allows for more flexible, programmable, and efficient network infrastructure, making it highly relevant in today's digital age This course gives practical implementation of modern networking concepts in simulators like cisco packet tracer, omnetpp and GNS. This gives a detail overview of tools used for modern networking.

Course Outcomes:
- Implement various network protocols and technologies, including IP SLA, IPv4 ACLs, SPAN, SNMP, and NetFlow.
- Configure network connectivity and address translation using GRE tunnels, VTP, NAT, and inter-VLAN routing.
- Understand and optimize network spanning tree operation through STP topology changes, RSTP, and advanced STP mechanisms.
- Establish and manage advanced networking features such as EtherChannel, OSPF, BGP, and IPsec VPNs.
- Simulate and analyze Software-Defined Networking (SDN) environments using OpenDaylight and Mininet/OpenFlow.

Curriculum:

Course Code	Course Title	Credits
PSCS104	**Software Defined Networking Practical**	**02**
Note: All the Practical's should be implemented using GNS3/EVENG/CISCO VIRL Link: GNS3:https://www.gns3.com/software/download EVE-NG: https://www.eve-ng.net/index.php/download/CISCO VIRL: https://learningnetwork.cisco.com/s/question/0D53i00000Kswpr/virl15-download Minimum 8 Practicals should be submitted as Journal Work.		
1	Implement IP SLA (IP Service Level Agreement)	
2	Implement IPv4 ACLs a) Standard ACL b) Extended ACL	
3	a) Implement SPAN Technologies (Switch Port Analyzer) b) Implement SNMP and Syslog c) Implement Flexible NetFlow	
4	a) Implement a GRE Tunnel b) Implement VTP c) Implement NAT	
5	Implement Inter-VLAN Routing	
6	Observe STP Topology Changes and Implement RSTP a) Implement Advanced STP Modifications and Mechanisms b) Implement MST	
7	a) Implement EtherChannel b) Tune and Optimize EtherChannel Operations	
8	OSPF Implementation a) Implement Single-Area OSPFv2 b) Implement Multi-Area OSPFv2 c) OSPFv2 Route Summarization and Filtering d) Implement Multiarea OSPFv3	
9	a) Implement BGP Communities b) Implement MP-BGP c) Implement eBGP for IPv4 d) Implement BGP Path Manipulation	
10	a) Implement IPsec Site-to-Site VPNs b) Implement GRE over IPsec Site-to-Site VPNs c) Implement VRF Lite	
11	Simulating SDN with a) OpenDaylight SDN Controller with the Mininet Network Emulator b) OFNet SDN network emulator	
12	Simulating OpenFlow Using MININET	

Learning Resources recommended:

1. TCPIP Protocol Suite, Behrouz A Forouzan , McGraw Hill Education; 4th edition, Fourth Edition, 2017
2. Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, William Stallings, Addison-Wesley Professional, 2016.
3. Software Defined Networks: A Comprehensive Approach, Paul Goransson and Chuck Black, Morgan Kaufmann Publications, 2014
4. SDN - Software Defined Networks by Thomas D. Nadeau & Ken Gray, O'Reilly, 2013

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I
with Effect from the Academic Year 2023-2024

Name of the Course	Principles of Compiler Design
Course Code	PSCS105
Class	M. Sc. Computer Science
Semester	I
No of Credits	2
Nature	Theory
Type	Major Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	This course works as a base for Natural language processing. It is considered as recent trends and technology. Developing skills in compiler design is a valuable endeavor, especially if you're interested in programming languages, software development, or system-level software. Employability in compiler design can be quite promising, as compilers are a critical component of software development and play a pivotal role in optimizing and translating high-level programming languages into machine code.

Principles of Compiler Design

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Front end of Compiler	15
2	Back end of Compiler	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

- Understand the essential concepts of compiler design, including lexical and semantic analysis, as well as intermediate code generation, equipping them with the skills needed to efficiently translate source code into optimized intermediate representations.
- Acquire knowledge about optimizing and generating code, managing runtime environments, and utilizing compiler tools effectively.

Curriculum:

Sr. No.	Modules / Units
1	Front end of Compiler (15 Hours)
	Introduction to Compiler Design: Role and importance of compilers, Phases of compilation process, Compiler architecture and components Lexical Analysis: Role of lexical analyzer, Regular expressions and finite automata, Lexical analyzer generators (e.g., Lex) Syntax Analysis: Role of parser, Context-free grammars, Top-down parsing (LL parsing) Bottom-up parsing (LR parsing), Syntax analyzer generators (e.g., Yacc/Bison) Semantic Analysis: Role of semantic analyzer, Symbol table management, Type checking and type systems, Attribute grammars Intermediate Code Generation: Intermediate representations (IR), Three- address code generation, Quadruples and triples, Syntax-directed translation
2	Back end of Compiler (15 Hours)
	Code Optimization: Data flow analysis, Common subexpression elimination, Constant folding and propagation, Loop optimization techniques Code Generation: Code generation techniques, Target machine description, Register allocation, Instruction selection and scheduling Runtime Environments: Activation records and stack management. Heap memory management, Call and return mechanisms, Exception handling Lexical and Syntax Error Handling: Error recovery strategies Error reporting and handling Introduction to Compiler Tools, Techniques and Advanced Topics in Compiler Design: Lexical and syntax analyzer generators, Code generation frameworks (e.g., LLVM), Debugging and testing compilers, Just-in-time (JIT) compilation, Parallel and concurrent programming support, Compiler optimization frameworks, Domain-specific language (DSL) compilation

Learning Resources Recommended:

A] Books and Textbooks:

1. Compilers: Principles, Techniques, and Tools" by Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman 2nd Edition, Pearson Publication, 2006 ISBN-13: 978- 0321486813
2. Modern Compiler Implementation in C" by Andrew W. Appel, 3rd Edition, Cambridge University Press, 2020, ISBN-13: 978-1108426631
3. Principles of Compiler Design" by D. M. Dhamdhere, 2nd Edition Publisher: McGraw-Hill Education, 2017, ISBN-13: 978-9339204608

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I
with Effect from the Academic Year 2023-2024

Name of the Course	NoSQL Technologies
Course Code	PSCS106
Class	M. Sc. Computer Science
Semester	I
No of Credits	2
Nature	Theory
Type	Major Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	This course gives understanding of NoSQL, MongoDB, Redis, HBase and Apache Cassandra which is considered as recent trends and technologies. NoSQL (Not Only SQL) technology has gained significant popularity in recent years due to its ability to handle large volumes of unstructured or semi-structured data and provide flexible and scalable data storage solutions.

NoSQL Technologies

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Introduction to NoSQL and Interfacing with NoSQL Data Stores	15
2	Querying, Indexing, and Data Management in NoSQL Databases	15
	Total	**30**

Course Outcomes:

At the end of the Course, the Learner will be able to

- Proficiently navigate NoSQL databases, effectively interacting with them, comprehending their storage architecture, and performing CRUD operations with ease.
- Understand NoSQL stores, optimize indexing and data ordering, ensure transactions and data integrity, and seamlessly utilize NoSQL databases in cloud environments.

Curriculum:

Sr. No.	Modules / Units
1	Introduction to NoSQL and Interfacing with NoSQL Data Stores (15 Hours)
	Basics Introduction to NoSQL: Characteristics of NoSQL, NoSQL Storage types, Advantages and Drawbacks, NoSQL Products **Interfacing and interacting with NoSQL**: Storing Data in and Accessing Data from MongoDB, Redis, HBase and Apache Cassandra, Language Bindings for NoSQL Data Stores **Understanding the storage architecture**: Working with Column Oriented Databases, HBase Distributed Storage Architecture, Document Store Internals, Understanding Key/Value Stores in Memcached and Redis, Eventually Consistent Non-relational Databases **Performing CRUD operations**: Creating Records, Accessing Data, Updating and Deleting Data
2	Querying, Indexing, and Data Management in NoSQL Databases (15 Hours)
	Querying NoSQL Stores: Similarities Between SQL and MongoDB Query Features, Accessing Data from Column-Oriented Databases Like HBase, Querying Redis Data Stores **Indexing and Ordering Data Sets**: Essential Concepts Behind a Database Index, Indexing and Ordering in MongoDB, ouchDB and Apache Cassandra Managing **Transactions and Data Integrity**: RDBMS and ACID, Distributed ACID Systems, Upholding CAP, Consistency Implementations **Using NoSQL in The Cloud**: Google App Engine Data Store, Amazon SimpleDB

Learning Resources recommended:

A] Books and Textbooks:

1. QL & NoSQL Databases, Andreas Meier • Michael Kaufmann, Springer Vieweg, 2019
2. Professional NoSQL by Shashank Tiwari, Wrox-John Wiley & Sons, Inc, 2011
3. SQL & NoSQL Databases, Andreas Meier • Michael Kaufmann, Springer Vieweg, 2019
4. NoSQL: Database for Storage and Retrieval of Data in Cloud, Ganesh Chandra Deka, CRC Press, 2017
5. Demystifying NoSQL by Seema Acharya, Wiley, 2020

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	NoSQL Technologies Practical
Course Code	PSCSP106
Class	M. Sc. Computer Science
Semester	I
No of Credits	2
Nature	Practical
Type (applicable to NEP only)	Major Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	This course gives practical implementation of NoSQL, MongoDB, Redis, HBase and Apache Cassandra which is considered as recent trends and technologies. NoSQL (Not Only SQL) technology has gained significant popularity in recent years due to its ability to handle large volumes of unstructured or semi-structured data and provide flexible and scalable data storage solutions.

Course Outcomes:

- Set up and configure various NoSQL databases, including MongoDB, Redis, HBase, and Apache Cassandra.
- Perform CRUD operations and retrieve data from different NoSQL databases using appropriate query languages and commands.
- Understand the storage architecture and internal workings of different NoSQL databases, such as column-oriented databases, document stores, and key/value stores.
- Implement data indexing and explore its impact on query performance in MongoDB and other NoSQL databases.
- Utilize NoSQL technologies in real-world scenarios, such as caching with Redis, data storage in Google App Engine Data Store, and Amazon SimpleDB data management.

Curriculum:

Course Code	Course Title	Credits
PSCSP106	**NoSQL Technologies Practical**	**02**
Note : -Practical's should be implemented using MongoDB, Redis and Hbase Minimum 8 Practicals should be submitted as Journal Work.		
1	**Lab Exercise: Setting up and Exploring MongoDB** a) Install MongoDB on your local machine or lab server. b) Create a new MongoDB database and collection. c) Insert sample data into the collection. d) Retrieve and display data from the collection using MongoDB queries.	

2	**Interacting with Redis**
	   a) Install Redis on your lab server or local machine.
	   b) Store and retrieve data in Redis using various data structures like strings, lists, and sets.
	   c) Implement basic Redis commands for data manipulation and retrieval

3	**Working with HBase**
	   a) Set up an HBase cluster in a lab environment.
	   b) Create an HBase table and define column families.
	   c) Insert sample data into the table.
	   d) Perform CRUD operations and retrieval of data in HBase.

4	**Apache Cassandra Operations**
	   a) Install and configure Apache Cassandra in a lab environment.
	   b) Create a keyspace and define a table schema.
	   c) Insert data into the table.
	   d) Perform CRUD operations and query data from Apache Cassandra.

5	**Querying MongoDB and HBase**
	   a) Write and execute MongoDB queries to retrieve specific data from a collection.
	   b) Perform queries on HBase tables using HBase shell commands.

6	**Redis Data Manipulation**
	   a) Use Redis commands to manipulate and modify data stored in different data structures.
	   b) Retrieve specific data using Redis query operations.

7	**Implementing Indexing in MongoDB**
	   a) Create an index on a specific field in a MongoDB collection.
	   b) Measure the impact of indexing on query performance.

8	**Data Storage in Redis**
	   a) Implement caching functionality using Redis as a cache store.
	   b) Store and retrieve data from Redis cache using appropriate commands.

9	**Using Google App Engine Data Store**
	   a) Create a project in Google App Engine and set up the Data Store.
	   b) Store and retrieve data from the Data Store using the provided API.

10	**Amazon SimpleDB Data Management**
	   1. Task 1: Set up an Amazon SimpleDB domain for data storage.
	   2. Task 2: Store and retrieve data from the SimpleDB domain using appropriate commands or APIs.

Learning Resources recommended:

A] Books and Textbooks:

1. QL & NoSQL Databases, Andreas Meier • Michael Kaufmann, Springer Vieweg, 2019
2. Professional NoSQL by Shashank Tiwari, Wrox-John Wiley & Sons, Inc, 2011
3. SQL & NoSQL Databases, Andreas Meier • Michael Kaufmann, Springer Vieweg, 2019
4. NoSQL: Database for Storage and Retrieval of Data in Cloud, Ganesh Chandra Deka, CRC Press, 2017
5. Demystifying NoSQL by Seema Acharya, Wiley, 2020

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I
with Effect from the
Academic Year 2023-2024

Name of the Course	Robotics
Course Code	PSCS107
Class	M. Sc. Computer Science
Semester	I
No of Credits	2
Nature	Theory
Type	Major Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	This course gives an introduction and overview of intelligent robot behavior and development. This is having huge weightage in industry and research. The Field of robotics continues to grow and expand into various industries and applications such as developing robotics hardware, software, or working on robotic systems integration,

Robotics

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Introduction to Robotics	15
2	Servo Motors	15
	Total	**30**

Course Outcomes:

At the end of the Course, the Learner will be able to
- Acquire a solid foundation in robotics, proficiently navigating robot building blocks, Raspberry Pi integration, basic robot construction, and effective robot programming techniques.
- Demonstrate competency in motor control, effectively utilize distance sensors, implement robot vision and voice communication, and master techniques for color processing, masking, and filtering in robotics applications.

Curriculum:

Sr. No.	Modules / Units
1	Introduction to Robotics (15 Hours)
	Introduction to Robotics: What is a robot? Examples of Advanced and impressive robots, Robots in the home, Robots in industry, **Exploring Robot Building Blocks** - Code and Electronics Technical requirements, **Introducing the Raspberry Pi** - Starting with Raspbian Technical requirements, Raspberry Pi controller on a robot Building Robot Basics **Technical requirements**: Robot chassis kit with wheels and motors, a motor controller, Powering the robot, Test fitting the robot, Assembling the base. **Robot Programming**: Programming technique, adding line sensors to our robot, creating line-sensing behaviour, and Programming RGB Strips in robot.
2	Servo Motors (15 Hours)
	Motors: Use and control of servo motors, pan, and tilt mechanism, Distance sensors, **Introduction to distance sensors and their usage**: Connecting distance sensors to robot and their testing. Creating a smart object avoidance behaviour. Creating a menu to select different robot behaviours, Distance and speed

	measuring sensors—encoders and odometry
	Robot Vision and Voice Communication: Setting up a Raspberry Pi Camera on the robot (software and hardware), Check the robot vision on a phone or laptop, Mask images with RGB strips,
	Colors, masking, and filtering – chasing coloured objects, detecting faces with Haar cascades, Finding objects in an image, Voice Communication with a robot

Learning Resources recommended:

A] Books and Textbooks:

1. Danny Staple, Robotics Programming, Packt Publishing, 2nd edition, Feb 2021
2. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, Wiley, 3rd Edition, 2019
3. D. K. Pratihar, Fundamentals of Robotics. Narosa Publication, 2016
4. Lentin Joseph, Learning Robotics Using Python, Packt Publishing Ltd., May 2015

Syllabus of Courses of Master of Commerce (M.Sc.) Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Robotics Practical
Course Code	PSCSP107
Class	M. Sc. Computer Science
Semester	I
No of Credits	2
Nature	Practical
Type	Major Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	The Field of robotics continues to grow and expand into various industries and applications such as developing robotics hardware, software, or working on robotic systems integration, This course gives practical implementation of intelligent robot component behavior and development. This is having huge weightage in industry and research.

Nomenclature: Robotics Practical

Course Outcomes:

- Leverage the features of the Raspberry Pi OS
- Discover how to configure a Raspberry Pi to build an AI-enabled robot
- Interface motors and sensors with a Raspberry Pi
- Code robot to develop engaging and intelligent robot behavior
- Explore AI behavior such as speech recognition and visual processing

Curriculum:

Course Code	Course Title	Credits
PSCSP107	**Robotics Practical**	**02**
Note: Following practical can be performed using Python and simulators, Raspberry Pi, and other hardware devices. Minimum 8 Practicals should be Submitted as Journal Work.		
1	Making a Raspberry Pi headless, and reaching it from the network using WiFi and SSH	
2	Using sftp upload files from PC.	
3	Write Python code to test motors.	
4	Write a script to follow a predetermined path	
5	Develop Python code for testing the sensors.	
6	Add the sensors to the Robot object and develop the line-following behaviour code.	
7	Using the light strip develop and debug the line follower robot	
8	Add pan and tilt service to the robot object and test it	

9	Create an obstacle avoidance behavior for robot and test it.
10	Detect faces with Haar cascades
11	Use the robot to display its camera as a web app on a phone or desktop, and then use the camera to drive smart color and face-tracking behaviours
12	Use a Raspberry Pi to run the Mycroft environment and connect it to a speaker/microphone combination

Learning Resources recommended:

A] Books and Textbooks:

1. Danny Staple, Robotics Programming, Packt Publishing, 2nd edition, Feb 2021
2. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, Wiley, 3rd Edition, 2019
3. D. K. Pratihar, Fundamentals of Robotics. Narosa Publication, 2016
4. Lentin Joseph, Learning Robotics Using Python, Packt Publishing Ltd., May 2015

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I
with Effect from the Academic Year 2023-2024

Name of the Course	UI/UX Design
Course Code	PSCS108
Class	M. Sc. Computer Science
Semester	I
No of Credits	2
Nature	Theory
Type	Major Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	The course is vastly focused on UI patterns and development. It is considered as a base for Software and website development. Employability in the field of User Interface (UI) and User Experience (UX) design is quite promising, as businesses and organizations recognize the critical role that user-centered design Plays in the success of products and services.

UI/UX Design

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Introduction to UI	15
2	Introduction to UX	15
	Total	**30**

Course Outcomes:

At the end of the Course, the Learner will be able to

- Possess a comprehensive understanding of user interface design (UI), effectively apply principles of interface design, and proficiently compose interface elements for optimal user experience.
- Demonstrate a strong grasp of UX fundamentals, effectively apply visual design principles, and proficiently utilize design tools to create engaging and user-centric interfaces.

Curriculum:

Sr. No.	Modules / Units
1	Introduction to UI (15 Hours)
	What is User Interface Design (UI): The Relationship Between UI and UX, Roles in UI/UX, A Brief Historical Overview of Interface Design, Interface Conventions, Approaches to Screen Based UI, Template vs Content, Formal Elements of Interface Design, Active Elements of Interface Design, Composing the Elements of Interface Design, UI Design Process, Visual Communication design component in Interface Design
2	Introduction to UX (15 Hours)
	UX Basics: Foundation of UX design, Good and poor design, Understanding Your Users, Designing the Experience Elements of user Experience, Visual Design Principles, Functional Layout, Interaction design, Introduction to the Interface, Navigation Design, User Testing, Developing and Releasing Your Design Design Tools: Interviews, writing personas: user and device personas, User Context, Building Low Fidelity Wireframe and High-Fidelity Polished Wireframe Using wireframing Tools, Creating the working Prototype using Prototyping tools, Sharing and Exporting Design

Learning Resources Recommended:

A] Books and Textbooks:
1. A Project Guide to UX Design: For user experience designers in the field or in the making (2nd. ed.). Russ Unger and Carolyn Chandler. New Riders Publishing, USA, 2012.
2. The Elements of User Experience: User-Centered Design for the Web and Beyond, Second Edition Jesse James Garrett, Pearson Education. 2011.
3. The Essential Guide to User Interface Design: An Introduction to GUI Design Principles and Techniques, Third Edition Wilbert O. Galitz , Wiley Publishing, 2007.
4. The UX Book Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson and Pardha S. Pyla, Elsevier, 2012

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I
with Effect from the Academic Year 2023-2024

Name of the Course	UI/UX Design Practical
Course Code	PSCSP108
Class	M. Sc. Computer Science
Semester	I
No of Credits	2
Nature	Practical
Type	Major Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	Employability in the field of User Interface (UI) and User Experience (UX) design is quite promising, as businesses and organizations recognize the critical role that user-centered design plays in the success of products and services. The course gives practical implementation of UI patterns and development. It is considered as base for Software and website development

Course Outcomes:

- Demonstrate proficiency in applying design principles to create visually appealing and user-friendly interfaces.
- Utilize design software and tools effectively to develop high-quality design solutions.
- Apply user-centred design principles to understand and meet user needs and expectations in design projects.
- Demonstrate creative thinking and problem-solving skills in designing interfaces that engage and delight users.
- Develop competence in using HTML/CSS to implement and showcase designs in web-based environments.

Curriculum:

Course Code	Course Title	Credits
PSCSP108	**UI/UX Design Practical**	**02**
1	Design appropriate UX element list for Yoga Day.	
2	Design for Digital-Visual design system for a brand. Take any brand of your choice	
3	Design for social media Project. Develop a web page in similar manner.	
4	Design for devices: understanding web & mobile. Design a simple web interface for mobile.	
5	Reading user personas and empathy maps. Based on random survey identify your customer.	

6	Design a simple low-fidelity wireframe.
7	Design a simple user interface with Colour & typography for UI
8	Design simple e commerce interface
9	Design a simple homepage for mobile shopee
10	Design a web interface for 2 different brands.

Learning Resources Recommended:

A] Books and Textbooks:
1. A Project Guide to UX Design: For user experience designers in the field or in the making (2nd. ed.). Russ Unger and Carolyn Chandler. New Riders Publishing, USA, 2012.
2. The Elements of User Experience: User-Centered Design for the Web and Beyond, Second Edition Jesse James Garrett, Pearson Education. 2011.
3. The Essential Guide to User Interface Design: An Introduction to GUI Design Principles and Techniques, Third Edition Wilbert O. Galitz , Wiley Publishing, 2007.
4. The UX Book Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson and Pardha S. Pyla, Elsevier, 2012

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I
with Effect from the Academic Year 2023-2024

Name of the Course	Research Methodology
Course Code	PSCS109
Class	M.Sc.
Semester	I
No of Credits	4
Nature	Theory
Type	Research Methodology
Highlight revision specific to employability/ entrepreneurship/ skill development	This paper enhances critical thinking and problem solving skills crucial for employability. Develops a solid foundation for data analysis, a key skill in various professions. The syllabus also fosters a research oriented mindset valuable for entrepreneurial ventures. Apart from this it sharpens skills in designing effective research strategies, strengthen literature searching capabilities and instills a meticulous approach to measurement and data collection. In addition to this it cultivates a commitment to academic integrity and equips individuals with ability to convey complex ideas with effective communication skills.

Research Methodology

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Fundaments of Research Methods	15
2	Research Design and Measurement Concepts and Literature Searching	15
3	Documentation, scientific writing and Academic Integrity	15
4	Hypothesis Testing and Communication Skills in Research	15
	Total	**60**

Course Outcomes:

Student will able to: -

- Understand fundamentals of research methods
- Learn design and measurement concepts of research
- Know data collection and analysis tools
- Test the hypothesis and communicate the research findings effectively
- Write research report, research proposal, research paper etc. and get acquainted with ethical considerations in research.

Curriculum:

Sr. No.	Modules / Units
1	Fundamentals of Research Methods (15 Hours)
	Definition of research, Role and objectives of research, importance of research, Applications and types of research, Creativity and innovation, Critical thinking, Research process and steps in it, Collecting and reviewing the literature, Conceptualization and Formulation of: research problem, identifying variables, constructing hypothesis and Synopsis. Interpretation of results and discussion
2	Research Design and Measurement Concepts and Literature Searching (15 Hours)

	Selecting and defining a research problem, Need for research design, Features of a good research design, Different research designs, Scales of measurements, Nominal, Ordinal, Internal and ratio scales, Errors in measurements, Validity and Reliability in measurement, Scale Construction Techniques. Digital: Web sources, E-journals, Journal access, Citation Index, Impact factor, H-index, Econsortium, UGC info net, eBooks, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Google Scholar,, Scopus.
3	**Documentation, scientific writing and Academic Integrity (15 Hours)**
	Documentation and scientific writing: Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography. for illustration, style, publications of scientific work, Research and Academic Integrity: Intellectual property rights (IPRs). Plagiarism, Copyright issues, Ethics in research, and case studies.
4	Research Testing(15 Hours)
	4.1. Hypotheses - a. Meaning, Nature of hypothesis b. Functions of Hypothesis c. Importance of Hypothesis d. Kinds of Hypothesis e. Characteristics of good hypothesis 4.2. Hypothesis testing - a. Null and alternate hypothesis b. Type I and Type II errors c. Level of significance d. Power of test e. p-value 4.3 Communication skills - a. Importance communication through English b. The process of communication and factors that influence communication. Sender, receiver, channel, code, topic, message, context, feedback, noise, filters, and barriers. c. Verbal and Non verbal communication d. Comparison of general communication and business communication. 4.4. Presentation skills - a. Structure of presentation b. Types of presentation, oral power point – Handling power point slides, organization, content, body language, gesture and voice modulation

Learning Resources recommended:

A] Books and Textbooks:

1. . Kothari C.R., ―Research Methodology, Methods and Techniques‖ (Second revised edition, New Age International Publication, 2004).

2. Saravanavel P., ―Research Methodology‖ (Kitab Mahal, Sixteenth edition, 2007).

3. Ranjit Kumar, ―Research Methodology, a step-by-step guide for beginners‖ (Pearson

4. Mark Saunders, Philip Lewis, Adrain Thornhiu, ―Research Methods for Business Students‖(Pearson Education ltd, Seventh edition, 2016)

B] Academic Journals and Publications:

1. Thesis & Assignment Writing–J Anderson, B.H.Dursten & M.Poole, Wiley Eastern, 1977
2. A Hand Book of Methodology of Research – P. Rajammal and P. Devadoss, R. M. M. Vidya Press,1976.
3. The Craft of Scientific Writing by Michael Alley, (Springer).
4. Research Methodology by R. Panneerselvam, PHI, New Delhi 2005
5. Research Methodology- A step by step Guide for Beginners, (2nd ed.) Kumar Ranjit, 2005, Pearson Education.
6. How to write and publish by Robert A. Day and Barbara Gastel, (Cambridge University Press).
7. S. Gupta, (2005). Research Methodology and Statistical techniques, Deep and Deep Publications (P) Ltd. New Delhi, India.
8. R. Kothari, (2008). Research Methodology, New Age International, New Delhi, India.
9. Standard /Reputed Journal authors' instructions.
10. Web resources: www.sciencedirect.com for journal references,
11. www.aip.org and www.aps.org for reference styles.
12. Web resources: www.nature.com, www.sciencemag.org,
13. www.springer.com, www.pnas.org, www.tandf.co.uk,
14. www.opticsinfobase.org for research updates.

Master of Science (M.Sc) Programme
Under Choice Based Credit System (CBCS)
Course Structure

M.Sc. II

No. of Courses	Semester II	Credits
	Major : Mandatory	
PSCS201	Machine Learning	4
PSCS202	Machine Learning Practical	2
PSCS203	Natural Language Processing	4
PSCS204	Natural Language Processing Practical	2
PSCS205	Simulation and Modelling	2
	Major : Elective (Any One from below)	
PSCS206	Bio-Informatics	
PSCS207	Embedded and IoT Technologies	4
PSCS208	Web Data Analytics	
PSCS209	On Job Training	4
	Total Credits	22

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester 44with Effect from the Academic Year 2023-2024

Name of the Course	Machine Learning
Course Code	PSCS201
Class	M. Sc. Computer Science
Semester	II
No of Credits	4
Nature	Theory
Type	Major Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Learning outcomes in the context of machine learning (ML) refer to the specific knowledge, skills, and abilities that a learner is expected to gain or achieve as a result of studying and practicing machine learning concepts and techniques. These learning outcomes can vary depending on the level of expertise and the specific course or program. This paper Gives overview about Machine Learning Techniques which is useful for industry implementation

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II
with Effect from the Academic Year 2023-2024
Modules at glance

Sr. No.	Modules	No. of Lectures
1	The Fundamentals of Machine Learning	15
2	Training Models	15
3	Support Vector Machines	15
4	Fundamentals of Deep Learning	15
	Total	**60**

Nomenclature: Machine Learning

Course Outcomes:

At the end of the Course, the Learner will be able to

- Possess a comprehensive understanding of machine learning, including its types, associated challenges, and performance measures, enabling them to effectively analyze, implement, and evaluate machine learning algorithms.
- Demonstrate proficiency in training models, understanding regression techniques, implementing gradient descent algorithms, and interpreting decision boundaries.
- Master Support Vector Machines, Decision Trees, and the CART Training Algorithm, enabling them to effectively apply these techniques to solve classification and regression problems in machine learning applications.
- Possess a comprehensive understanding of deep learning, proficiently utilize core components of neural networks, and effectively manipulate tensors and operations.

Curriculum:

Sr. No.	Modules / Units
1	The Fundamentals of Machine Learning (15 Hours)
	Understanding Machine Learning, Need and Relevance of Machine Learning, Types of Machine Learning, Supervised Learning, Unsupervised Learning & Reinforcement Learning. Challenges of Machine Learning, Testing and Validation. Classification, MNIST Dataset, Performance Measures, Confusion Matrix, Precision and Recall, Precision/Recall Tradeoff, The ROC Curve, Multicl
2	Training Models (15 Hours)
	Linear Regression, Gradient Descent, Batch Gradient Descent, Stochastic Gradient Descent, Mini-batch Gradient Descent, Polynomial Regression, Learning Curves, The Bias/Variance Tradeoff, Ridge Regression, Lasso Regression, Early Stopping, Logistic Regression, Decision Boundaries, Softmax Regression, Cross Entropy.
3	Support Vector Machines (15 Hours)
	Linear SVM Classification, Soft Margin Classification, Nonlinear SVM Classification, Polynomial Kernel, Gaussian RBF Kernel, SVM Regression, Decision Trees, Training and Visualizing a Decision Tree, Making Predictions, The CART Training Algorithm, Gini Impurity vs Entropy, Regularization Hyperparameters.
4	Fundamentals of Deep Learning (15 Hours)
	What is Deep Learning? Need Deep Learning? Introduction to Artificial Neural Network (ANN), Core components of neural networks, Multi-Layer Perceptron (MLP), Activation functions, Sigmoid, Rectified Linear Unit (ReLU), Introduction to Tensors and Operations, Tensorflow framework

Learning Resources recommended:

A] Books and Textbooks:

1. Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow Concepts, Tools, and Techniques to Build Intelligent Systems by AurélienGéron, Second Edition, O'reilly, 2019
2. Deep Learning with Python by François Chollet Published by Manning 2018
3. Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew G. Barto, Second Edition ,2014
4. Introduction to Machine with Python - A Guide for Data Scientists by Andreas C. Müller & Sarah Guido O'reilly 2016
5. Artificial Neural Networks with TensorFlow 2 ANN Architecture Machine Learning Projects Poornachandra Sarang by Apress, 2021

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II
with Effect from the Academic Year 2023-2024

Name of the Course	Machine Learning Practical
Course Code	PSCS202
Class	M. Sc. Computer Science
Semester	II
No of Credits	2
Nature	Practical
Type	Major Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	"Learning outcomes" in the context of machine learning (ML) refer to the specific knowledge, skills, and abilities that a learner is expected to gain or achieve as a result of studying and practicing machine learning concepts and techniques. These learning outcomes can vary depending on the level of expertise and the specific course or program. This paper Gives overview about Machine Learning Techniques which is useful for industry implementation

Nomenclature: Machine Learning Practical

Course Outcomes:
- Implement diverse ML algorithms: linear regression, logistic regression, multinomial logistic regression, SVM, decision trees, MLP.
- Apply ML techniques to different datasets.
- Utilize batch gradient descent with early stopping for softmax regression training.
- Develop neural network models for problem solving.
- Use TensorFlow for image classification.
- Implement regression models for fuel efficiency prediction using TensorFlow and Auto MPG dataset.

Curriculum:

Course Code	Course Title	Credits
PSCS202	**Machine Learning Practical**	**02**
Note: All the Practical's should be implemented using Python and TensorFlow. Link:Python :https://www.python.org/downloads/ TensorFlow :https://www.tensorflow.org/install Minimum 8 Practicals should be Submitted as Journal Work.		
1	Implement Linear Regression (Diabetes Dataset)	
2	Implement Logistic Regression (Iris Dataset)	
3	Implements Multinomial Logistic Regression (Iris Dataset)	
4	Implement SVM classifier (Iris Dataset)	

5	Train and fine-tune a Decision Tree for the Moons Dataset
6	Train an SVM regressor on the California Housing Dataset
7	Implement Batch Gradient Descent with early stopping for Softmax Regression
8	Implement MLP for classification of handwritten digits (MNIST Dataset)
9	Classification of images of clothing using Tensorflow (Fashion MNIST dataset)
10	Implement Regression to predict fuel efficiency using Tensorflow (Auto MPG dataset)

Learning Resources recommended:

A] Books and Textbooks:

1. Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow Concepts, Tools, and Techniques to Build Intelligent Systems by AurélienGéron, Second Edition, O'reilly, 2019

2. Deep Learning with Python by François Chollet Published by Manning 2018

3. Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew G. Barto, Second Edition ,2014

4. Introduction to Machine with Python - A Guide for Data Scientists by Andreas C. Müller & Sarah Guido O'reilly 2016

5. Artificial Neural Networks with TensorFlow 2 ANN Architecture Machine Learning Projects Poornachandra Sarang by Apress, 2021

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II
with Effect from the Academic Year 2023-2024

Name of the Course	Natural Language Processing
Course Code	PSCS203
Class	M. Sc. Computer Science
Semester	II
No of Credits	4
Nature	Theory
Type	Major Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	The motive of the paper is to make learners aware about various blooming skills in natural language processing. Basic concepts of chatbot application designing, sentiment analysis of natural language, etc… will help learners about development techniques required for bot creation, language translation, robotic simulation which are needed in industry. This will help learners to get job like NLP engineer, NLP AI platform engineer, NLP Data Scientist.

Modules at a Glance

Natural Language Processing

Sr. No.	Modules	No. of Lectures
1	Introduction to Natural Language Processing (NLP) and Language Modelling	15
2	Morphology & Parsing in NLP	15
3	Semantics and Word Embedding	15
4	NLP Applications and Case Studies	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

- Understanding the importance and concepts of Natural Language Processing (NLP)
- Applying algorithms available for the processing of linguistic information and computational properties of natural languages.
- Adeptly comprehend semantics and word embedding techniques, enabling them to effectively represent and analyze textual data for natural language processing tasks.
- Proficiently apply natural language processing (NLP) techniques to various real-world applications and analyze case studies, enabling them to understand the practical implications and challenges of NLP.

Curriculum:

Sr. No.	Modules / Units
1	Introduction to Natural Language Processing (NLP) and Language Modelling (15 Hours)

	Introduction to NLP: Introduction and applications, NLP phases, Difficulty of NLP including ambiguity; Spelling error and Noisy Channel Model; Concepts of Parts- of speech and Formal Grammar of English. Language Modelling: N-gram and Neural Language Models Language Modelling with N-gram, Simple N-gram models, smoothing (basic techniques), Evaluating language models; Neural Network basics, Training; Neural Language Model, Case study: application of neural language model in NLP system development Python Libraries for NLP: Using Python libraries/packages such as Natural Language Toolkit (NLTK), spaCy, genism	
2	Morphology & Parsing in NLP	(15 Hours)
	Computational morphology & Parts-of-speech Tagging: basic concepts; Tagset; Lemmatization, Early approaches: Rule-based and TBL; POS tagging using HMM, Introduction to POS Tagging using Neural Model. Parsing Basic concepts: top-down and bottom-up parsing, treebank; Syntactic parsing: CKY parsing; Statistical Parsing basics: Probabilistic Context-Free Grammar (PCFG); Probabilistic CKY Parsing of PCFGs.	
3	Semantics and Word Embedding	(15 Hours)
	Semantics Vector Semantics: Words and Vector; Measuring Similarity; Semantics with dense vectors; SVD and Latent Semantic Analysis Embeddings from prediction: Skip-gram and Continuous Bag of words; Concept of Word Sense; Introduction to WordNet	
4	NLP Applications and Case Studies	(15 Hours)
	Intelligent Work Processors: Machine Translation; User Interfaces; man-machine Interfaces: Natural language Querying Tutoring and Authoring Systems. Speech Recognition Commercial use of NLP: NLP in customer Service, Sentiment Analysis, Emotion Mining, Handling Frauds and SMS, Bots, LSTM & BERT models, Conversations	

Learning Resources recommended:

[A] Books and Textbooks:
1. Speech and Language Processing, Jurafsky Dan and Martin James H., 3rd Edition, Pearson, 2018.
2. Natural Language Processing with Python, Steven Bird, Ewan Klein, and Edward Loper, 2nd Edition, O'Reilly, 2016.
3. Practical Natural Language Processing with Python, Mathangi Sri, Apress, 2021
4. Handbook of Computational Linguistics and Natural Language Processing, Martin Whitehead, Clanrye International, 202
5. Handbook of Natural Language Processing, Nitin Indurkhya, and Fred J. Damerau, Pearson; 2nd edition, 2008
6. Foundations of Statistical Natural Language Processing‖, Manning, Christopher and Heinrich, Schutze, MIT Press, 1997

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II
with Effect from the Academic Year 2023-2024

Name of the Course	Natural Language Processing Practical
Course Code	PSCS204
Class	M. Sc. Computer Science
Semester	II
No of Credits	2
Nature	Practical
Type	Major Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Practical implementation of techniques aware learners about implementation of concepts they learned in theory. Hands o on will help them improve their skill in NLP.

Nomenclature: Natural Language Processing Practical

Course Outcomes:
- The ability to describe the concepts of morphology, syntax, semantics, discourse & pragmatics of natural language
- Discover various linguistic and statistical features relevant to the basic NLP task, namely, spelling correction, morphological analysis, parts-of-speech tagging, parsing, and semantic analysis
- Assess and Evaluate NLP based systems
- Ability to choose appropriate solutions for solving typical NLP subproblems (tokenizing, tagging, parsing)
- Analyse NLP problems to decompose them inadequate independent components and develop real-life applications.

Curriculum:

Course Code	Course Title	Credits
PSCSP514	**Natural Language Processing Practical**	**02**

Note: - The following set of Practical can be performed using any Python Libraries for NLP such as NLTK, spaCy, genism: Link:-https://www.python.org/downloads/ Minimum 8 Practicals should be Submitted as Journal Work.

1	Write a program to implement sentence segmentation and word tokenization
2	Write a program to Implement stemming and lemmatization
3	Write a program to Implement a tri-gram model
4	Write a program to Implement PoS tagging using HMM & Neural Model
5	Write a program to Implement syntactic parsing of a given text
6	Write a program to Implement dependency parsing of a given text
7	Write a program to Implement Named Entity Recognition (NER)
8	Write a program to Implement Text Summarization for the given sample text
	CASE STUDIES
9	Consider a scenario of applying NLP in Customer Service. Design and develop an application that demonstrates NLP operations for working with tasks and data like voice calls, chats, Ticket Data, Email Data. Process the data to understand the voice of the Customer (intent mining, Top words, word cloud, classify topics). Identify issues, replace patterns and gain insight into sales chats.
10	Consider a scenario of Online Review and demonstrate the concept of sentiment analysis and emotion mining by applying various approaches like lexicon-based approach and rule-based approaches.
11	Apply NLP in Banking, Financial Services, and Insurance. Design Application to detect frauds and work with SMS data
12	Demonstrate the use of NLP in designing Virtual Assistants. Apply LSTM, build conversational Bots

Learning Resources recommended:

[A] Books and Textbooks:

1. Speech and Language Processing, Jurafsky Dan and Martin James H., 3rd Edition, Pearson, 2018.
2. Natural Language Processing with Python, Steven Bird, Ewan Klein, and Edward Loper, 2nd Edition, O'Reilly, 2016.
3. Practical Natural Language Processing with Python, Mathangi Sri, Apress, 2021
4. Handbook of Computational Linguistics and Natural Language Processing, Martin Whitehead, Clanrye International, 202
5. Handbook of Natural Language Processing, Nitin Indurkhya, and Fred J. Damerau, Pearson; 2nd edition, 2008
6. Foundations of Statistical Natural Language Processing‖, Manning, Christopher and Heinrich, Schutze, MIT Press, 1997

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II
with Effect from the Academic Year 2023-2024

Name of the Course	Simulation and Modelling
Course Code	PSCS205
Class	M. Sc. Computer Science
Semester	II
No of Credits	2
Nature	Theory
Type	Major Mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Learning simulation and modeling involves understanding the principles, techniques, and tools used to create and analyze mathematical or computational models of real-world systems. This paper Teaches various simulation techniques related to Computer Technologies. Employability in the field of simulation and modeling is promising, as these skills are highly valuable in a wide range of industries and applications.

Simulation and Modelling

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Introduction to Simulation and Statistical Models	15
2	Random Number Generation, Random Variate Generation, Input Modeling, and Output Analysis	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

- Possess a comprehensive understanding of simulation, including its principles, techniques, and application in queuing models, enabling them to effectively model and analyze complex systems.
- Proficiently generate random numbers, generate random variates, verify and validate simulation models, and conduct output analysis for a single model, ensuring the reliability and accuracy of simulation.

Curriculum:

Sr. No.	Modules / Units
1	Introduction to Simulation and Statistical Models (15 Hours)
	Introduction to Simulation: System and System environment, Components of system, Type of systems, Type of models, Steps in simulation study, Advantages and Disadvantages of simulation. **General Principles**: Concepts of discrete event simulation, List processing Statistical Models in Simulation: Useful statistical model, Discrete distribution, Continuous distribution, Poisson process, Empirical distribution. **Queueing Models**: Characteristics of Queueing systems, Queueing notations, Long run measures of performance of Queueing systems, Steady state behavior of infinite population Markovian models, Steady state behavior finite population model, Network of Queues
2	Random Number Generation, Random Variate Generation, Input Modeling, and Output Analysis (15 Hours)
	Random Number Generation: Properties of random numbers, Generation of pseudo random numbers, Techniques for generating random numbers, Tests for random numbers. **Random Variate Generation**: Inverse transform technique, Convolution method, Acceptance rejection techniques 9. Input Modeling: Data Collection, Identifying the Distribution of data, Parameter estimation, Goodness of fit tests, Selection input model without data, Multivariate and Time series input models. **Verification and Validation of Simulation Model**: Model building, Verification, and Validation, Verification of simulation models, Calibration and Validation of models **Output Analysis for a Single Model**: Types of simulations with respect to output analysis, Stochastic nature of output data, Measure of performance and their estimation, Output analysis of terminating simulators, Output analysis for steady state simulation

Learning Resources Recommended:

1. Discrete Event System Simulation, Jerry Banks, John Carson, Barry Nelson, David Nicol, 3rd Edition, Pearson, 2013
2. Simulation Modeling and Analysis, 5th Edition, McGRAW- HILL, Averill Law, W. David Kelton, 2012
3. System Simulation, Geoffrey Gordon, Pearson, 2007
4. Theory of Modeling and Simulation, Bernard P. Zeigler, Tag Gon Kim , Herbert praehofer, Academic Press, 2011
5. System Simulation with Digital Computer, Narsingh Deo, PHI

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II

with Effect from the Academic Year 2023-2024

Name of the Course	Bioinformatics
Course Code	PSCS206
Class	M. Sc. Computer Science
Semester	II
No of Credits	2
Nature	Theory
Type	Major Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	The Subject is designed for studying various bioinformatic techniques in the case of Computer Science. It plays a crucial role in various sectors, including genomics, pharmaceuticals, healthcare, and biomedical research. Here are some key factors and considerations that can enhance your employability in bioinformatics.

Bioinformatics

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Biological Data Analysis	15
2	Computational Tools and Methods	15
	Total	**30**

Course Outcomes:

At the end of the Course, the Learner will be able to
- Possess a foundational understanding of biology, bioinformatics principles, and techniques for sequence and structure analysis, empowering them to effectively analyze biological data.
- Proficiently navigate genomics and transcriptomics data, effectively visualize and report findings, critically analyze bioinformatics methods, and assess ethical, legal, and social implications, enabling them to contribute responsibly to the field of bioinformatics..

Curriculum:

Sr. No.	Modules / Units
1	Biological Data Analysis (15 Hours)
	Biological Foundations: Introduction to molecular biology concepts and terminology, DNA, RNA, and protein structure and function, Genetic variation and mutation **Introduction to Bioinformatics**: Overview of bioinformatics and its applications in biology and medicine, Introduction to biological databases and data formats, Introduction to sequence analysis, structure analysis **Sequence Analysis**: Sequence alignment algorithms (pairwise and multiple sequence alignment), Sequence database searching (BLAST, FASTA), Hidden Markov Models (HMMs) for sequence analysis, Phylogenetic analysis and

	evolutionary tree construction **Structure Analysis**: Protein structure prediction methods (homology modeling, ab initio methods), Protein structure visualization and analysis tools, Drug discovery	
2	Computational Tools and Methods	(15 Hours)
	Genomics and Transcriptomics: Analyzing and manipulating genomic sequences, working with genome annotations and gene features, Analyzing gene expression data (RNA-Seq, microarray), Identifying differentially expressed genes **Data Visualization and Reporting**: Visualizing bioinformatics data, Creating interactive visualizations of biological data Machine Learning and Data Mining in **Bioinformatics**: Introduction to machine learning algorithms and techniques, Feature selection and dimensionality reduction in biological data, Predictive modeling for biological data (classification, regression) **Ethical, Legal, and Social Implications**: Ethical considerations in bioinformatics research, Privacy and data security in genomic data, social and policy issues in bioinformatics and personalized medicine	

Learning Resources recommended:

A] Books and Textbooks:
1. Bioinformatics: Sequence and Genome Analysis by David W. Mount Publisher: Cold Spring Harbor Laboratory Press Publication (4th edition), 2021,
2. Python for Bioinformatics by Tiago Antao, Packt Publishing Publication, 2015
3. Python for Biologists: A complete programming course for beginners" by Martin Jones CreateSpace Independent Publishing Platform, 2013
4. Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases, and Analytical Tools by Supratim Choudhuri, Academic Press Publication, 2014
5. Bioinformatics Programming Using Python: Practical Programming for Biological Data by Mitchell L. Model, O'Reilly Media, 2009

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II
with Effect from the Academic Year 2023-2024

Name of the Course	Bioinformatics Practical
Course Code	PSCSP206
Class	M. Sc. Computer Science
Semester	II
No of Credits	2
Nature	Practical
Type (applicable to NEP only)	Major Elective
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	The Subject is designed for studying various bioinformatic techniques in the case of Computer Science. It plays a crucial role in various sectors, including genomics, pharmaceuticals, healthcare, and biomedical research. Here are some key factors and considerations that can enhance your employability in bioinformatics.

Nomenclature: Bioinformatics Practical

Course Outcomes:

1. Gain a solid understanding of fundamental concepts and principles in bioinformatics, including sequence analysis, genome analysis, protein structure prediction, and gene expression analysis

2. Acquire the ability to analyze and interpret biological data, such as DNA or protein sequences, microarray data, or next-generation sequencing data

3. Learn statistical methods and techniques for extracting meaningful insights from large datasets.

4. Develop skills in using bioinformatics tools and software packages commonly used in the field, such as BLAST, EMBOSS and Biopython

5. Awareness of Ethical and Legal Considerations

6. Develop the ability to stay updated with the latest advancements and emerging trends in bioinformatics research and technologies

Curriculum:

Course Code	Course Title	Credits
PSCSP206	**Bioinformatics Practical**	**02**

Note: Software and Tools : Python.
Minimum 8 Practicals should be Submitted as Journal Work.

1	Sequence Manipulation ● Read and parse sequence data from files ● Perform basic sequence manipulations (e.g., reverse complement, translation)
2	Sequence Alignment ● Perform pairwise sequence alignment using algorithms like Needleman-Wunsch or Smith-Waterman ● Implement multiple sequence alignment using methods such as ClustalW or MUSCLE
3	Database Searching ● Perform sequence searches against databases (e.g., BLAST or FASTA) ● Retrieve and analyze search results
4	Protein Structure Analysis ● Retrieve protein structures from databases like PDB ● Calculate structural properties (e.g., secondary structure, solvent accessibility) ● Perform structure visualization and analysis
5	Genomic Data Analysis ● Retrieve genomic data from databases (e.g., NCBI) ● Analyze gene annotations, promoter regions, or regulatory elements ● Perform genomic variant analysis
6	Data Preprocessing ● Cleaning and preprocessing biological data (e.g., gene expression data, DNA sequences) ● Handling missing values, outliers, and normalization of data ● Feature selection and dimensionality reduction techniques
7	Classification ● Applying machine learning algorithms (e.g., decision trees, random forests, support vector machines) to classify biological samples or sequences ● Evaluating model performance using metrics such as accuracy, precision, recall, and F1-score
8	Regression ● Building regression models to predict quantitative biological properties (e.g., protein structure, gene expression levels) ● Assessing model performance using metrics such as mean squared error or R-squared
9	Clustering ● Applying clustering algorithms (e.g., k-means, hierarchical clustering) to group similar biological samples or sequences ● Assessing clustering quality using metrics such as silhouette coefficient or

		Rand index
10	Visualizing clusters and analyzing their biological significance • Data Visualization: • Generate plots, graphs, and figures to visualize bioinformatics results • Use libraries like Matplotlib, Seaborn, or ggplot in Python or R for visualization • Create interactive visualizations using tools like D3.js or Plotly	

Learning Resources recommended:

A] Books and Textbooks:
1. Bioinformatics: Sequence and Genome Analysis by David W. Mount Publisher: Cold Spring Harbor Laboratory Press Publication (4th edition), 2021,
2. Python for Bioinformatics by Tiago Antao, Packt Publishing Publication, 2015
3. Python for Biologists: A complete programming course for beginners" by Martin Jones CreateSpace Independent Publishing Platform, 2013
4. Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases, and Analytical Tools by Supratim Choudhuri, Academic Press Publication, 2014
5. Bioinformatics Programming Using Python: Practical Programming for Biological Data by Mitchell L. Model, O'Reilly Media, 2009

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II
with Effect from the
Academic Year 2023-2024

Name of the Course	Embedded and IoT Technology
Course Code	PSCS207
Class	M. Sc. Computer Science
Semester	II
No of Credits	2
Nature	Theory
Type	Major Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	The Subject gives overview of Embedded and IoT Technologies which is useful for smart computing. Employability in embedded systems and the Internet of Things (IoT) is promising, as these fields continue to grow and have a significant impact on various industries.

Embedded and IoT Technology

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Embedded System Basics	15
2	Advanced IOT Technologies	15
	Total	**30**

Course Outcomes:

At the end of the Course, the Learner will be able to
- Possess a comprehensive understanding of embedded systems, the fundamentals of IoT, sensing principles, and wireless sensor networks, empowering them to design and implement innovative solutions for interconnected smart systems.
- Understand IoT gateway technologies, cloud and fog computing concepts, IoT security principles, communication protocols, data analytics techniques, and the social implications of IoT, enabling them to design, deploy, and manage robust and secure IoT solutions.

Curriculum:

Sr. No.	Modules / Units
1	Embedded System Basics (15 Hours)
	Introduction to Embedded Systems- Design of Embedded Systems, Memory Architecture, Input/Output. Basic electronics: Semiconductors, Transistors, BJT, Flip Flops, Resistors, Capacitors, CMOS, MOSFET, FPGA, Relays. Microcontrollers, UART Communications, SPI-peripherals interface, I2C communication, Wireless Sensor Network (WSN) **Basics of IOT**- Introduction IoT, IoT Building Blocks -Hardware and Software: The basic IoT building blocks, smart thing components and capabilities, basics of Packet Tracer with reference to IoT, basics of IoT gateway, Cloud, and analytics **Sensing Principles and Wireless Sensor Network**: Sensor fundamentals and classification of sensors, physical principles of some common sensors, basics of WSNs, WSN architecture and types, layer-level functionality of WSN protocol stack.
2	Advanced IOT Technologies (15 Hours)
	IoT Gateway: IoT architecture domains, IoT gateway architecture, IoT gateway functionalities, IoT gateway selection criteria, IoT gateway and edge computing, edge computing-based solution for specific IoT applications IoT Protocol Stack, **IoT Cloud and Fog Computing**: Components of IoT Cloud architecture, usage of application domains of IoT Cloud platforms, layered architecture of Fog computing, distinguish Fog computing from other related terms IoT Applications: Main applications of IoT, Implementation details of various IoT application domains **Security, Communication and Data analytics in IOT**- IoT Security: Security constraints in IoT systems, security requirements of IoT systems, IoT attacks, security threats at each layer of IoT architecture, design secure IoT system for specific application **Social IoT**: Nature of social relationships among IoT Devices, functionality of different components of social IoT architecture, social aspects of smart devices in IoT applications Packet Tracer and IoT: Basics of Packet Tracer and Blockly programming language, design simple IoT projects in Packet Tracer.

Learning Resources recommended:
A] Books and Textbooks:

1. Introduction to Embedded Systems – Cyber physical systems Approach Edward Ashford Lee & Sanjit Arunkumar Seshia Second Edition — MIT Press — 2017
2. Enabling the Internet of Things Fundamentals, Design and Applications by Muhammad Azhar Iqbal, Sajjad Hussain, Huanlai Xing, Muhammad Ali Imran Wiley Pub.1st Edition 2021
3. Introduction Embedded Systems by K.V. Shibu Second Edition McGraw Hills–2017
4. Build your own IoT Platform Develop a Fully Flexible and Scalable Internet of Things Platform in 24 Hours by Anand Tamboli , 2019 ,Apress

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II
with Effect from the Academic Year 2023-2024

Name of the Course	Embedded and IoT Technology Practical
Course Code	PSCSP207
Class	M. Sc. Computer Science
Semester	II
No of Credits	2
Nature	Practical
Type	Major Elective
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	The Subject gives overview of Embedded and IoT Technologies which is useful for smart computing. Employability in embedded systems and the Internet of Things (IoT) is promising, as these fields continue to grow and have a significant impact on various industries

Nomenclature: Embedded and IoT Technology Practical

Course Outcomes:

- The course is designed to enable students, to understand and implement IoT in industry.
- Design and executive projects in IoT with Automatic Identification and Data Capture.

Curriculum:

Course Code	Course Title	Credits
PSCSP207	**Embedded and IoT Technology Practical**	**02**

Note: - The following set of practicals should be implemented in CodeVisionAVR, Proteus8, Cisco Packet Tracer, Keli V5, Python

Link: -

Python:https://www.python.org/downloads/

CodeVisionAVR :https://www.codevision.be/

Proteus8:https://www.labcenter.com/downloads/

Cisco Packet Tracer:https://www.netacad.com/courses/packet-tracer

Keli V5: https://www.keil.com/download/

Minimum 8 Practicals should be Submitted as Journal Work.

1	Design and implement basics embedded circuits 1. Automatic Alarm system- Alarm should get trigger by senor 2. Timer based buzzer 3. Sensor based Counting device
2	Demonstrate communication between two embedded devices using UART port
3	Built an IoT system to send ticket before entering the bus.
4	Demonstrate an IoT based game which can be played between two player who are physically at a considerable distance.
5	Develop a IoT application which will record the movement and orientation of your phone and give the data back to the PC
6	Develop an IoT application that will raise an alarm whenever with going to rain outside based on the weather prediction data.
7	Deploy an IoT application which will alert you by beeping or vibrating your phone whenever you get someone call your name.
8	Develop an IoT application for monitoring water levels in tanks and automatically start the motor to fill the tank if the level goes below the critical level.
9	Develop an IoT module to which measure the intensity of light and send the same to your PC/ Phone
10	Develop an IoT application for Motion detection.

Learning Resources recommended:

A] Books and Textbooks:

1. Introduction to Embedded Systems – Cyber physical systems Approach Edward Ashford Lee & Sanjit Arunkumar Seshia Second Edition — MIT Press — 2017
2. Enabling the Internet of Things Fundamentals, Design and Applications by Muhammad Azhar Iqbal, Sajjad Hussain, Huanlai Xing, Muhammad Ali Imran Wiley Pub.1st Edition 2021
3. Introduction Embedded Systems by K.V. Shibu Second Edition McGraw Hills–2017
4. Build your own IoT Platform Develop a Fully Flexible and Scalable Internet of Things Platform in 24 Hours by Anand Tamboli , 2019 ,Apress

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I
with Effect from the Academic Year 2023-2024

Name of the Course	Web Data Analytics
Course Code	PSCS208
Class	M. Sc. Computer Science
Semester	II
No of Credits	2
Nature	Theory
Type	Major Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	Web mining is the process of discovering useful information and patterns from the vast amount of data available on the World Wide Web. It involves techniques and methodologies from data mining, machine learning, and information retrieval to extract valuable knowledge from web content, structure, and usage data.

Web Data Analytics

Modules at a Glance

Sr. No.	Modules	No. of Lectures
3	Introduction to Web Mining	15
4	Social Network & Link Analysis	15
	Total	**30**

Course Outcomes:

At the end of the Course, the Learner will be able to
- Possess a solid understanding of web mining techniques, basic principles of information retrieval, opinion mining methodologies, and web usage mining algorithms, empowering them to effectively extract valuable insights from web data.
- Proficiently analyze social networks, develop webpage crawlers for data collection, and apply data modeling techniques for webpage usage mining.

Curriculum:

Sr. No.	Modules / Units
1	Introduction to Web Mining (15 Hours)
	Web Mining-Data Mining, Basic Concepts, Difference, Mining Sequential Patterns on Prefix Span, Generating Rules from Sequential Patterns. **Basic Concepts of Information Retrieval**, Information Retrieval Models, Relevance feedback, Evaluation measures Text and Web Page Preprocessing, Inverted Index and Its Compression, latent semantic indexing, Web Search, Web Spamming **Opinion Mining and Web Usage Mining**: Web Information Retrieval, Sentiment Classification, Feature based Opinion Mining and summarization, Comparative Sentence and Relation Mining, Opinion Search and Opinion Spam. Web Usage Mining.
2	Social Network & Link Analysis (15 Hours)

	Social Network-Link Analysis, Scrapy using python (without pipelining), Social Network Analysis, Co-Citation and Bibliographic Coupling, PageRank, HITS, Community Discovery **Webpage crawlers and usage mining**: Basic Crawler Algorithm, Implementation Issues, Universal Crawlers, Focused Crawlers, Topical Crawlers, Crawler Ethics and Conflicts, **Data modelling and webpage usage mining:** Discovery and analysis of web usage patterns, Recommender systems and collaborative filtering, query log mining

Learning Resources Recommended:

A] Books and Textbooks:
1. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data by Bing Liu (Springer Publications) 2017 publication
2. Data Mining: Concepts and Techniques, Second Edition Jiawei Han, Micheline Kamber (Elsevier Publications),2017
3. Web Mining: Applications and Techniques by Anthony Scime,2010
4. Mining the Web: Discovering Knowledge from Hypertext Data by Soumen Chakrabarti 2010

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II

with Effect from the Academic Year 2023-2024

Name of the Course	Web Data Analytics Practical
Course Code	PSCSP208
Class	M. Sc. Computer Science
Semester	II
No of Credits	2
Nature	Practical
Type (applicable to NEP only)	Major Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	Web mining is the process of discovering useful information and patterns from the vast amount of data available on the World Wide Web. It involves techniques and methodologies from data mining, machine learning, and information retrieval to extract valuable knowledge from web content, structure, and usage data.

Nomenclature: Web Data Analytics Practical

Course Outcomes:

- Develop deep understanding of mining techniques exclusively for the Internet
- Understand and develop analytics for social media data.
- Design and implementation of various web analytical tool to understand complex unstructured data on the Internet for aiding individuals and Businesses to grow their business.

Curriculum:

Course Code	Course Title	Credits
PSCSP208	**Web Data Analytics Practical**	**02**
Note: - The following set of practical's should be implemented in Scrape, python: Link:-Python : https://www.python.org/downloads/ **Minimum 8 Practicals should be Submitted as Journal Work.**	
1	Scrape an online E-Commerce Site for Data. 1. Extract product data from Amazon - be it any product and put these details in the MySQL database. One can use pipeline. Like 1 pipeline to process the scraped data and other to put data in the database and since Amazon has some restrictions on scraping of data, ask them to work on small set of requests otherwise proxies and all would have to be used. 2. Scrape the details like color, dimensions, material etc. Or customer ratings by features	
2	Scrape an online Social Media Site for Data. Use python to scrape information from twitter.	

3	Page Rank for link analysis using python Create a small set of pages namely page1, page2, page3 and page4 apply random walk on the same
4	Perform Spam Classifier
5	Demonstrate Text Mining and Webpage Pre-processing using meta information from the web pages (Local/Online).
6	Apriori Algorithm implementation in case study.
7	Develop a basic crawler for the web search for user defined keywords.
8	Develop a focused crawler for local search.
9	Develop a programme for deep search implementation to detect plagiarism in documents online.
10	Sentiment analysis for reviews by customers and visualize the same.

Learning Resources Recommended:

A] Books and Textbooks:
1. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data by Bing Liu (Springer Publications) 2017 publication
2. Data Mining: Concepts and Techniques, Second Edition Jiawei Han, Micheline Kamber (Elsevier Publications),2017
3. Web Mining: Applications and Techniques by Anthony Scime,2010
4. Mining the Web: Discovering Knowledge from Hypertext Data by Soumen Chakrabarti 2010

Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II
with Effect from the Academic Year 2023-2024

Name of the Course	On Job Training/ Field Project
Course Code	PSCS209
Class	M. Sc. Computer Science
Semester	II
No of Credits	4
Nature	Practical
Type	On Job Training/ Field Project
Highlight revision specific to employability/ entrepreneurship/ skill development	The courses' primary goal is to provide students with the financial knowledge and skills necessary to create budgets and allocate resources to various organizational units. also filled with all the topics that will help you build your understanding to specialize in any IT Companies, School, Colleges and Others

Guidelines and Evaluation pattern for On Job Training/ Field Project (100 Marks)

Introduction:

Inclusion of On Job Training/ Field Project in the course curriculum of the M.Sc. programme is one of the ambitious aspect in the programme structure. The main objective of inclusion of On Job Training/ Field Project is to inculcate ability to interpret particular aspect of the study in his/ her own words.

Guidelines for On Job Training

On-the-Job Training/Field Project: Students will be required to undertake a designated project or tasks in an organization or industry relevant to their field of study. The course aims to provide students with practical exposure and hands-on experience in a professional work environment related to their field of study.

Course Objectives:

By the end of the course, students should be able to:
1. Gain exposure to real-world insights and apply theoretical knowledge to practical situations
2. Enhance his skills regarding problem-solving, decision-making, and communication skills.
3. Understand organizational dynamics and work culture.
4. Build industry connections and networking opportunities

Course Duration:

Minimum 1 months / 120 hours of On Job Training with an Organization/ Startup/ Charitable Organization/ Private firm/ Private Limited Company.
- The theme of the internship should be based on any study area of the Major course
- Project Report should be of minimum 50 pages
- Experience Certificate and evaluation report is Mandatory

Report Structure:

The students will be required to submit a comprehensive report at the end of the On-the-Job Training. A project report has to be brief in content and must include the following aspects:

a) **Title Page:**

Mentioning the title of the report, name of the student, program, institution, and the period of training/project.

b) **Certificate of Completion:**

A certificate issued by the organization or supervisor confirming the successful completion of the training/project.

c) **Declaration:**

A statement by the student declaring that the report is their original work and acknowledging any assistance or references used.

d) **Acknowledgments:**

Recognizing individuals or organizations that provided support, guidance, or resources during the training/project.

e) **Table of Contents:**

Providing a clear outline of the report's sections and page numbers.

f) **Introduction on the Company:**

A Concise representation of company/ organization defining its scope, products/ services and its SWOT analysis.

g) **Your Role in the Organization during the on Job Training:**

The key aspects handled, the department under which you were deployed and brief

Summary report duly acknowledged by the reporting head.

h) **Challenges**:

The challenges confronted while churning out theoretical knowledge into practical

world.

i) **Conclusion:**

A brief overview of your experience and suggestions to bridge the gap between theory

and practice.

Guidelines for Field Project

The Field Project for Master of Science provides students with invaluable experiences in understanding socio-economic contexts and development-related issues. Through field visits, research, and innovative thinking, students gain practical insights into addressing complex challenges and contributing to the socio-economic development of communities. The rubrics for evaluation ensure a comprehensive assessment of students' learning and contributions during the project.

Course Outcomes:

1. Apply theoretical knowledge and concepts acquired during the academic program to real-world work scenarios.
2. Develop practical skills and competencies necessary for successful professional engagement.
3. Demonstrate effective problem-solving, decision-making, and critical thinking abilities in a work environment.
4. Adapt to and navigate organizational dynamics and work culture in the chosen industry.
5. Prepare a comprehensive report documenting the training/project experience, findings, and recommendations.

Report Structure:
The students will be required to submit a comprehensive report at the end of the Field Project. A project report has to be brief in content and must include thefollowing aspects:

a) **Title Page:**

Mentioning the title of the report, name of the student, program, institution, and the

period of training/project.

b) **Certificate of Completion:**

A certificate issued by the organization or supervisor confirming the successful

completion of the training/project.

c) Declaration:

A statement by the student declaring that the report is their original work and acknowledging any assistance or references used.

d) Acknowledgments:

Recognizing individuals or organizations that provided support, guidance, or resources during the training/project.

e) Table of Contents:

Providing a clear outline of the report's sections and page numbers.

f) Introduction:

Background information about the field project and its significance. Objectives and scope of the project.

g) Literature Review:

Overview of relevant literature and studies related to the chosen field and development issues.

h) Methodology:

Description of the research methods used for data collection, such as interviews, surveys, or observations. Explanation of the data analysis techniques employed.

i) Field Visits and Observations:

Detailed accounts of the field visits, including locations, dates, and observations made during the visits. Photographs or visual aids to support the observations.

j) Data Analysis:

Presentation and interpretation of the data collected during the field visits. Charts, graphs, or tables to illustrate the findings.

i) Understanding Policies and Programmes:

Explanation of relevant government policies and programmes related to the identified development issues. Assessment of how these policies are implemented in the field context.

ii) Identified Socio-Economic Problems:

Detailed description of the complex socio-economic problems observed in the community. Analysis of the root causes and implications of these problems.

k) Innovative Solutions:

Presentation of innovative practices proposed to address the identified problems.

Description of the action plans to implement these solutions

l) Conclusion & Recommendations:

Summary of the key findings and outcomes of the field project. Reflections on the overall experience and learning during the project. Specific recommendations for policymakers, organizations, or stakeholders to address the identified issues.

m) References & Appendices:

List of all sources cited in the project report. Additional supporting materials, such as interview transcripts, survey questionnaires, or field visit notes can be attached as appendices

Broad guidelines for project report:

The project report based on 'On Job Training/ Field Project' shall be prepared as per the broad guidelines given below:

- Font type: Times New Roman
- Font size: 12-For content, 14-for Title
- Line Space: 1.5-for content and 1-for in table work
- Paper Size: A4
- Margin: in Left-1.5, Up-Down-Right-1
- The Project Report shall be bounded.

Rubrics for Field Project Report Evaluation:
   1. **Content (40 Points)**

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Introduction and Objectives	Clear and well-defined	Clearly stated	Adequately stated	Vaguely stated	Not stated or unclear

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Literature Review	Comprehensive and relevant	Relevant and adequate	Limited relevance	Inadequate or missing	Not included
Field Visits and Observations	Thorough and detailed	Adequate information	Limited data collection	Incomplete or lacking detail	No field observations made
Data Analysis	In-depth analysis	Analyzed effectively	Some analysis performed	Superficial or incomplete	No data analysis conducted
Understanding of Policies and Programmes	Strong understanding	Adequate understanding	Limited understanding	Inadequate or inaccurate	No understanding displayed
Identified Socio-Economic Problems	Comprehensive and clear	Clearly identified	Some problems identified	Inadequate or vague	No problems identified
Conclusion	Concise and conclusive	Clear and summarized	Somewhat conclusive	Unclear or missing	No conclusion provided
Recommendations	Well-developed and feasible	Feasible and relevant	Partially feasible	Infeasible or lacking detail	No recommendations given

2. Presentation (20 points):

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Structure and Organization	Well-structured and logical	Clear organization	Adequate organization	Lacks structure	Disorganized and unclear

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Language and Clarity	Clear, concise, and fluent	Fluent language	Some clarity issues	Difficult to understand	Incoherent and unclear
Visual Presentation	Professional and engaging	Neat and presentable	Some visual aids used	Minimal use of visuals	No visuals used
Grammar and Spelling	No errors in grammar/spelling	Minor errors	Some errors	Frequent errors	Numerous errors

3. Research Methodology (20 points):

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Appropriate Method Selection	Highly appropriate	Mostly appropriate	Adequate method choice	Inappropriate methods	No clear method used
Data Collection and Analysis	Thorough data collection	Adequate data analysis	Limited analysis	Incomplete or weak analysis	No data analysis done

4. Creativity and Innovation (10 points):

Criteria	Excellent (10)	Good (8)	Satisfactory (6)	Needs Improvement (4)	Unsatisfactory (2)
Innovation in Problem Solving	Highly innovative	Innovative solutions	Some creativity shown	Lacks creativity	No innovative solutions

5. Overall Impression (10 points):

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Overall Quality	Exceptional quality	High quality	Acceptable quality	Below acceptable	Poor quality
Contribution and Learning	Outstanding contribution	Significant contribution	Some contribution	Limited or no learning	No contribution or learning

Front page & Index Format for Project Report:

'*Title of the Project*"

A Project Submitted

to

R. P. Gogate college of Arts & Science and

R.V. Jogalekar College of Commerce Autonomous College

under

University of Mumbai

In the partial fulfillment of the degree of

Master of Science (Computer Science)

By

"*Name of the Student*"

Under Guidance Of

"*Name of the Guiding Teacher*"

Through

GOGATE-JOGALEKAR COLLEGE AUTONOMOUS, RATNAGIRI

YEAR:

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Evaluation Scheme

For 4 Credit Theory Course:

The allocation of marks for the Internal Assessment and Semester End Examinations are as follows

Evaluation for the course will be of 100 marks conducted in a 60: 40 pattern. 60 marks will be for semester end examination and 40 marks will be for internal evaluation.

Internal Evaluation: 40 Marks (40%)

Method	Marks
Mid-Term Class Test ● It should be conducted using any **learning management system** such as **Moodle**(Modular object-oriented dynamic learning environment) ● The test should have **20 MCQ's** which should be solved in a time duration of **40 minutes.**	20
Assignment/ Case study/ Presentations ● Assignment / Case Study Report / Presentation can be uploaded on any **learning management system**.	10
Attendance	05
Behavior	05

Semester End Evaluation: 60 Marks (60%)

Duration: 2Hours

	All questions are compulsory.		
Question	Based on	Options	Marks
Q.1	Unit I	*Any 2 out of 4*	12
Q.2	Unit II	*Any 2 out of 4*	12
Q.3	Unit III	*Any 2 out of 4*	12
Q.4	Unit IV	*Any 2 out of 4*	12
Q.5	Unit I, II, III, IV	*Objective Based*	12

Evaluation Scheme

For 2 Credit Theory Course:

      The allocation of marks for the Internal Assessment and Semester End Examinations are as follows

      Evaluation for the course will be of 50 marks conducted in a 30:20 pattern. 30 marks will be for semester end examination and 20 marks will be for internal evaluation.

Internal Evaluation: 20 Marks (40%)

Method	Marks
Mid-Term Class Test ● It should be conducted using any **learning management system** such as **Moodle**(Modular object-oriented dynamic learning environment) ● The test should have **20 MCQ's** which should be solved in a time duration of **40 minutes.**	10
Assignment/ Case study/ Presentations ● Assignment / Case Study Report / Presentation can be uploaded on any **learning management system**.	05
Attendance & Behavior	05

Semester End Evaluation: 30 Marks (60%)

Duration: 1 Hour

Question	Based on	Sub-Question	Options	Marks
		All questions are compulsory.		
Q.1	Unit I	A	*Any 2 out of 4*	6
		B	*Any 1 out of 2*	4
Q.2	Unit II	A	*Any 2 out of 4*	6
		B	*Any 1 out of 2*	4
Q.3	Unit I, II	A	*Any 2 out of 4*	6
		B	*Any 1 out of 2*	4

Evaluation Scheme

For Practical Course:

The allocation of marks for the Internal Assessment and Semester End Examinations are as follows

Evaluation for the course will be of 50 marks conducted in a 60: 40 pattern. 30 marks will be for semester end examination and 20 marks will be for internal evaluation.

Evaluation Pattern

Internal Examination: 20 Marks (40%)

Sr No	Criterion	Marks
1	Journals containing minimum 10 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

Semester End Examination: 30 Marks (60%)

Sr No	Criterion	Marks
1	One Practical Question **OR** Combination of Practical Questions **OR** Combination of Practical Question and Theory Question **Duration : 2 Hours**	25
2	Viva	05

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment & Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 16 out of 40 or 8 out of 20) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60 or 12 out of 30) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment & Semester End Examination together.

Performance Grading:

Letter Grades and Grade Points

Semester GPA/ Program CGPA Semester/Program	% of Marks	Alpha-Sign / Letter Grade Result
9.00-10.00	90.0 -100	0 (Outstanding)
$8.00 \leq 9.00$	$80.0 \leq 90.0$	A+ (Excellent)
$7.00 \leq 8.00$	$70.0 \leq 80.0$	A (Very Good)
$6.00 \leq 7.00$	$60.0 \leq 70.0$	B+ (Good)
$5.50 \leq 6.00$	$55.0 \leq 60.0$	B (Above Average)
$5.00 \leq 5.50$	$50.0 \leq 55.0$	C (Average)
$4.00 \leq 5.00$	$40.0 \leq 50.0$	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

SMART Criteria for Course Outcomes:

Specific: Each Course outcome is industry specific and research oriented. It gives brief introduction and implementation of recent trends and technologies.

Measurable: Each outcome can be measured through assessments, tests, mini-projects and projects to determine the level of understanding and proficiency achieved by the students.
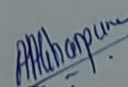
Achievable: The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

Relevant: The outcomes are relevant to the subject of financial services and capital market, addressing important concepts, types, and mechanisms involved.

Time-bound: The outcomes are expected to be achieved by the end of the course, providing a clear timeline for assessment and evaluation.

Date: 29-04-2024
Place: Ratnagiri

The Chairperson,
BoS of Computer Science