

Affiliated to
University of Mumbai



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

Master of Science (MSc.) Programme
Two Year Integrated Programme
Four Semesters

Course: Computer Science

Syllabus for MSc Semester III & IV

Under Choice Based Credit System (CBCS)

To be implemented from Academic
Year- 2023-2024

Preamble

The syllabus is having following important motives as per research and industry requirements.

- To be fundamentally strong at the core subject of Computer Science.
- To apply programming, computational skills, and the latest technological trends for industrial solutions.
- Offer specialization in a chosen area.
- Create research temper among students in the whole process.
- To encourage, motivate and prepare the Learners for Lifelong- learning.
- To inculcate professional and ethical attitude, good leadership qualities, and commitment to social responsibilities in the Learner's thought process.

This syllabus for the semester - III and semester – IV has tried to continue the steps initiated in the semester- I and semester –II to meet the goals set. This proposes Four Tracks in semester III. The student must select one paper from each track.

The Four Elective in semester- III is mentioned below:

- Advanced Computing
- Security
- Computer Networking
- Data Science

The syllabus also offers an internship with industry and project implementation in semester IV, each of which has weights equivalent to a full course. Introducing different Electives in Tracks in semester –III and offering the opportunity to choose those Electives will give the student added advantage of high-level competency in the advanced and emerging areas of computer science. This will equip the student with industry readiness as an internship in an IT or IT related organization gives a practical exposure to what is learned and what is practiced. The strong foundation given in the core courses in different semesters will give enough confidence to the learner to face and adapt to the changing trends and requirements of industry and academia.

The syllabus prepares a strong army of budding computer science researchers. The syllabus was designed on the firm belief that focusing on student-driven research on cutting edge and emerging trends with lots of practical experience will make the learning more interesting and stimulating. It is hoped that the student community and teacher colleagues will appreciate the thrust, direction, and treatment given in the syllabus.

Name of Programme	M Sc Computer Science
Level	PG
No of Semesters	04
Year of Implementation	2023
Programme Specific Outcomes (PSO)	<ol style="list-style-type: none"> 1. To be fundamentally strong at core subject of Computer Science. 2. To apply programming and computational skills for industrial solutions. 3. Broad understanding of latest technological trends. 4. To identify opportunities for establishing an enterprise for immediate Employment. 5. Able to understand and apply fundamental research concepts. 6. Able to use efficient soft skills for professional development. 7. Engage in independent and life-long learning for continued professional development.
Relevance of PSOs to the local, regional, national, and global developmental needs (200 words)	<ol style="list-style-type: none"> 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

	<p>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.</p> <ol style="list-style-type: none">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.
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EVALUATION

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks in the first part and by conducting the Semester End Examinations with 60% marks in the second part. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % (40 Marks)

Method	Marks
Mid-Term Class Test <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> Assignment / Case Study Report / Presentation can be uploaded on any learning management system. 	10
Attendance	05
Behavior	05

B) Semester End Examination: 60% (60 Marks)

Duration: The examination shall be of two hours' duration.

Question Paper Pattern

- There shall be five questions each of 12 marks.
- All questions shall be compulsory with internal options.
- Question may be subdivided into sub-questions a, b, c... and the allocation of marks depends on the weightage of the unit.
- Last question i.e. Q.5 will consist of Objective questions like MCQ, Fill in the Blanks and True or False.

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

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) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60) 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	O (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)
Abs (Absent)	-	Absent

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

(To be implemented from Academic Year- 2023-24)

Course Name	Course Code	Elective Name	Credits
Advanced Computing	PSCS3011	Elective-1: Web3 Technologies	4
	PSCS3012	Elective-2: (Trends in Cloud Computing	
Security	PSCS3021	Elective-1: Cryptography and Cryptanalysis	4
	PSCS3022	Elective-2: Cyber Security and Risk Assessment	
Computer Networking	PSCS3031	Elective-1: Server and Data Centric Networking	4
	PSCS3032	Elective-2: Wireless Networking	
Data Science	PSCS3041	Elective-1: Data Visualization	4
	PSCS3042	Elective-2: Big Data Analytics	4

Course Name	Course Code	Elective Name (Practical)	Credits
Advanced Computing	PSCSP3011	Elective-1: Web3 Technologies	2
	PSCSP3012	Elective-2: (Trends in Cloud Computing	
Security	PSCSP3021	Elective-1: Cryptography and Cryptanalysis	2
	PSCSP3022	Elective-2: Cyber Security and Risk Assessment	
Computer Networking	PSCSP3031	Elective-1: Server and Data Centric Networking	2
	PSCSP3032	Elective-2: Wireless Networking	
Data Science	PSCSP3041	Elective-1: Data Visualization	2
	PSCSP3042	Elective-2: Big Data Analytics	

Master of Science (M.Sc) Programme
Under Choice Based Credit System Course Structure
M.Sc. IV
(To be implemented from Academic Year- 2023-24)

Course Code	Semester IV	Credits
PSCS401	Robotics (Online Mode)	4
PSCS402	Advanced Deep Learning (Online Mode)	4
PSCSP401	Robotics Practical(Online Mode)	2
PSCSP402	Advanced Deep Learning Practical(Online Mode)	2
PSCSP403	Internship with Industry	6
PSCSP404	Project Implementation	6
Total Credits		24

SMART Criteria for Course Outcomes:

Specific: Each course outcome is specific, outlining the knowledge and skills students are expected to acquire in relation to the specific topics covered.

Measurable: Each outcome can be measured through assessments, tests, or 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.

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

Name of the Course	Advanced Computing (Web3 Technology)
Course Code (refer to student handbook)	PSCS3011
Class	M.Sc. Computer Science
Semester	III
No of Credits	04
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: Advanced Computing (Web3 Technology)

Course Outcomes:

- To cover the technical aspects of crypto currencies, block chain technologies, and distributed consensus.
- To familiarize potential applications for Bitcoin-like cryptocurrencies
- To Basics of smart contracts, decentralized apps, and decentralized anonymous organizations (DAOs)
- To know Solidity programming

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Introduction to Web3 Technologies	Blockchain: Growth of blockchain technology, Distributed systems, the history of blockchain and Bitcoin, Blockchain, Consensus, CAP theorem and blockchain, Decentralization using blockchain, Methods of decentralization, Routes to decentralization, Blockchain and full ecosystem decentralization, The consensus problem, Analysis and design, Classification, Algorithms, Bitcoin: Overview, Cryptographic keys, Transactions, Blockchain Mining, Bitcoin network, Wallets, Bitcoin payments, Innovation in Bitcoin, Advanced protocols, Bitcoin investment, and buying and selling Bitcoin	15
II	Smart Contracts & Ethereum	Smart Contracts: History, Definition Ricardian contracts, Smart contract templates, Oracles, Deploying smart contracts, The DAO Ethereum: Overview, Ethereum network, Components of the Ethereum ecosystem, The Ethereum Virtual Machine (EVM), Smart contracts, Blocks and Blockchain, Wallets and client software, Nodes and miners, APIs, tools, and DApps, Supporting protocols, Programming languages, Ethereum Development Environment: Overview, Test networks, Components of a private network, starting up the private network, mining on the private network, Remix IDE, MetaMask, Using MetaMask and Remix IDE to deploy a smart contract	15
III	Serenity, Ethereum, Hyperledger & Tokenization	Web3: Exploring Web3 with Geth, Contract deployment, interacting with contracts via frontends Development frameworks: Serenity, Ethereum 2.0—an overview, Development, phases, Architecture Serenity: Ethereum 2.0—an overview, Development phases, Architecture Hyperledger: Projects under Hyperledger, Hyperledger reference architecture, Hyperledger Fabric, Hyperledger Sawtooth, Setting up a sawtooth development environment. Tokenization: Tokenization on a blockchain, Types of tokens, Process of tokenization, Token offerings, Token standards, Trading and finance, DeFi, Building an ERC-20 token, emerging concepts	15
IV	Solidity	Introduction to Solidity Programming: Layout of a	15

Programming (Skill Enhancement)	Solidity Source File, Structure of a Contract, Types, Units, and Globally Available Variables, Input Parameters and Output Parameters, Control Structures, Function Calls, Creating Contracts via new, Order of Evaluation of Expressions, Assignment, Scoping and Declarations, Error handling: Assert, Require, Revert and Exceptions Smart Contracts: Solidity Programming –Contracts, Creating Contracts, Visibility and Getters, Function Modifiers, Constant State Variables, Functions, Inheritance, Abstract Contracts, Interfaces, Libraries.	
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Learning Resources recommended:

TEXTBOOKS:

1. Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition 2020
2. Andreas M. Antonopoulos, Dr.Gavin wood —Mastering Ethereum|| O‘Reilly Media Inc,2019
3. Ritesh Modi, —Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and BlockChain||, Packt Publishing.

REFERENCE BOOKS:

1. Josh Thompson, „Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming“, Create Space Independent Publishing Platform, First Edition - 2017.

Evaluation Pattern**A. Internal Evaluation:**

Method	Marks
Mid-Term Class Test <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> Assignment / Case Study Report / Presentation can be uploaded on any learning management system. 	10
Attendance	05
Behavior	05

B. Semester End Evaluation (Paper Pattern)

Duration: 2Hours

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

Name of the Course	Practical Course on Elective-1: Advanced Computing (Web3 Technologies)
Course Code (refer to student handbook)	PSCSP3011
Class	M.Sc. Computer Science
Semester	III
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: Practical Course on Elective-1: Advanced Computing (Web3 Technologies)

Course Outcomes:

- To cover the technical aspects of crypto currencies, block chain technologies, and distributed consensus.
- To familiarize potential applications for Bitcoin-like cryptocurrencies
- To Basics of smart contracts, decentralized apps, and decentralized anonymous organizations (DAOs)
- To know Solidity programming

Curriculum:

Course Code	Course Title	Credits
PSCSP3011	Practical Course on Elective-1: Advanced Computing (Web3 Technologies)	02
Note: Following practical can be performed on Windows or Linux Minimum 8 Practicals need to be submitted as Journal work.		
1	Install and understand Docker container, Node.js, Java and Hyperledger Fabric, Ethereum and perform necessary software installation on local machine/create instance on Cloud to run.	
2	Create and deploy a block chain network using Hyperledger Fabric SDK for Java	
3	Interact with a block chain network. Execute transactions and requests against a block chain network by creating an app to test the network and its rules	
4	Deploy an asset-transfer app using block chain. Learn app development within a Hyperledger Fabric network	
5	Use block chain to track fitness club rewards Build a web app that uses Hyperledger Fabric to track and trace member rewards	
6	Car auction network: A Hello World example with Hyperledger Fabric Node SDK and IBM Block chain Starter Plan. Use Hyperledger Fabric to invoke chain code while storing Results and data in the starter plan	
7	Develop an IoT asset tracking app using Block chain. Use an IoT asset tracking device to improve a supply chain by using Block chain, IoT devices, and Node-RED	
8	Create a global finance block chain application with IBM Block chain Platform Extension for VS Code. Develop a Node.js smart contract and web app for a Global Finance with block chain use case	
9	Develop a voting application using Hyperledger and Ethereum. Build a decentralized app that combines Ethereum's Web3 and Solidity smart contracts with Hyperledger's hosting Fabric and Chaincode EVM	
10	Create a block chain app for loyalty points with Hyperledger Fabric Ethereum Virtual Machine. Deploy Fabric locally with EVM and create a proxy for interacting with a smart contract through a Node.js web app	

Evaluation Pattern

A. Internal Evaluation : 20 Marks

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

B. Semester End Evaluation (Paper Pattern): 30 Marks

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

Name of the Course	Advanced Computing (Trends in Cloud Computing)
Course Code (refer to student handbook)	PSCS3012
Class	M.Sc. Computer Science
Semester	III
No of Credits	04
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: **Advanced Computing (Trends in Cloud Computing)**

Course Outcomes:

- Learners will be able to understand the how the cloud services work.
- Learners will be able to develop and launch applications in the cloud environment
- Explore various frameworks and APIs that are used for developing cloud-based applications.
- Handling data in a Cloud environment

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Basic Concepts & Techniques for Cloud Application Development	Fundamentals of Cloud Application Development: Business case for implementing cloud application, Requirements collection for cloud application development, Cloud service models and deployment models, Open challenges in Cloud Computing: Cloud interoperability and standards, scalability and fault tolerance, security, trust, and privacy Application Development framework: Accessing the clouds: Web application vs Cloud Application, Frameworks: Model View Controller (MVC). Cloud platforms in Industry – Google AppEngine, Microsoft Azure, Openshift, CloudFoundry	15
II	Cloud Service Delivery Environment and API	Sessions & API: Storing objects in the Cloud, Session management, Working with third party APIs: Overview of interconnectivity in Cloud ecosystems. Facebook API, Twitter API, Google API. Architecting for the Cloud: Best practices in architecture cloud applications in AWS cloud, Amazon Simple Queue Service (SQS), RabbitMQ Managing the data in the Cloud: Securing data in the cloud, ACL, OAuth, OpenID, XACML, securing data for transport in the cloud, scalability of applications and cloud services.	15
III	DevOps and Containers in Cloud	Basics of DevOps: Introduction to DevOps, Continuous Deployment: Containerization with Docker, Orchestration (Kubernetes and Terraform), Automating Infrastructure on Cloud, Application Deployment and Orchestration using ECS, ECR & EKS, Application Deployment using Beanstalk, Configuration Management using OpsWorks Application: Designing a RESTful Web API, PubNub API for IoT to cloud, mobile device as IoT, Mobile cloud access	15
IV	Azure & GCP Essentials (Skill Enhancement)	Azure essentials: Azure Compute and Storage, Azure Database and Networking, Monitoring and Managing Azure Solutions, GCP Compute and Storage, GCP Networking and Security, Google App Engine (PaaS) Cloud applications: Amazon Simple Notification Service (Amazon SNS), multi-player online game hosting on cloud resources, building content delivery networks using clouds	15

Learning Resources recommended:

TEXTBOOKS:

1. Kevin L. Jackson. Scott Goessling, Architecting Cloud Computing Solutions, Packt Publishing 2018
2. Shailendra Singh, Cloud Computing: Focuses on the Latest Developments in Cloud Computing, Oxford University Press; First edition, June 2018

Evaluation Pattern

A. Internal Evaluation:

Method	Marks
Mid-Term Class Test <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • Assignment / Case Study Report / Presentation can be uploaded on any learning management system. 	10
Attendance	05
Behavior	05

B. Semester End Evaluation (Paper Pattern)

Duration: 2Hours

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

Name of the Course	Practical Course on Elective-2: Advanced Computing (Trends in Cloud Computing)
Course Code (refer to student handbook)	PSCSP3012
Class	M.Sc. Computer Science
Semester	III
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: Practical Course on Elective-2: Advanced Computing (Trends in Cloud Computing)

Course Outcomes:

- Learners will be able to gain hands on training on working with cloud applications.
- Learners will be able to develop and launch applications in the cloud environment
- Explore various frameworks and APIs that are used for developing cloud-based applications
- Handling data in a Cloud environment

Curriculum:

Course Code	Course Title	Credits
PSCSP3012	Practical Course on Elective-2: Advanced Computing (Trends in Cloud Computing)	02
Note: Following practical can be performed on Eclipse IDE, Dropbox API, Apache tomcat server 7.0/8.0, Google AppEngine		
Minimum 8 Practicals need to be submitted as Journal work.		
1	Using the software like / API / Tools JDK 1.7/1.8, Eclipse IDE, Dropbox API, Apache tomcat server 7.0/8.0, Google AppEngine API, Servlets, Struts, Spring framework design and develop Web applications using MVC Framework	
2	Installing and configuring the required platform for Google App Engine	
3	Studying the features of the GAE PaaS model.	
4	Creating and running Web applications (Guest book, MVC) on localhost and deploying the same in Google App Engine	
5	Developing an ASP.NET based web application on the Azure platform	
6	Creating an application in Dropbox to store data securely. Develop a source code using Dropbox API for updating and retrieving files	
7	Installing Cloud Foundry in localhost and exploring CF commands.	
8	Cloud application development using IBM Bluemix Cloud.	
9	Installing and Configuring Dockers in localhost and running multiple images on a Docker Platform.	
10	Configuring and deploying VMs/Dockers using Chef/Puppet Automation tool	

Learning Resources recommended:**TEXTBOOKS:**

1. Kevin L. Jackson, Scott Goessling, Architecting Cloud Computing Solutions, Packt Publishing 2018
2. Shailendra Singh, Cloud Computing: Focuses on the Latest Developments in Cloud Computing, Oxford University Press; First edition, June 2018

Evaluation Pattern

A. Internal Evaluation : 20 Marks

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

B. Semester End Evaluation (Paper Pattern): 30 Marks

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

Name of the Course	Security (Cryptography and Cryptanalysis)
Course Code (refer to student handbook)	PSCS3021
Class	M.Sc. Computer Science
Semester	III
No of Credits	04
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: **Security (Cryptography and Cryptanalysis)**

Course Outcomes:

- To develop the foundation for the study of cryptography and its use in security.
- To understand the application of Number Theory and Algebra for the design of cryptographic Algorithms
- To understand the role of cryptography in communication over an insecure channel.
- To analyze and compare symmetric-key encryption and public-key encryption schemes based on different security models

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Classic Cryptography Techniques	<p>Cryptosystems and Basic Cryptographic Tools: Introduction, Secret-key Cryptosystems, Public-key Cryptosystems, Block and Stream Ciphers, Hybrid Cryptography, Hybrid Cryptography, Message Integrity, Message Authentication Codes, Signature Schemes, Nonrepudiation, Certificates, Hash Functions, Cryptographic Protocols, Security</p> <p>Classical Cryptography: Introduction to Some Simple Cryptosystems, Shift Cipher, Substitution Cipher, Affine Cipher, Vigenere Cipher, Hill Cipher, Permutation Cipher, Stream Ciphers, Cryptanalysis, Cryptanalysis of the Affine Cipher, Cryptanalysis of the Substitution Cipher, Cryptanalysis of the Vigenere Cipher, Cryptanalysis of the Hill Cipher, Cryptanalysis of the LFSR Stream Cipher.</p> <p>Perfect Secrecy: Introduction, Perfect Secrecy, Entropy, Properties of Entropy, Spurious Keys, and Unicity Distance</p>	15
II	Advanced Encryption, Integrity, and Authentication	<p>Block Ciphers and Stream Ciphers: Substitution-Permutation Networks, Linear Cryptanalysis, Differential Cryptanalysis, Data Encryption Standard, Advanced Encryption Standard, Modes of Operation, Stream Ciphers</p> <p>Hash Functions and Message Authentication: Hash Functions and Data Integrity, Security of Hash Functions, Iterated Hash Functions, Sponge Construction, Message Authentication Codes, Unconditionally Secure MACs</p> <p>RSA Cryptosystem and Factoring: Public-key Cryptography, Number Theory-Euclidean Algorithm, Chinese Remainder Theorem, Other Useful Facts, RSA Cryptosystem, Primality Testing, Square Roots Modulo n, Factoring Algorithms, Rabin Cryptosystem, Semantic Security of RSA</p>	15
III	Public-Key Cryptography and Identity Verification	<p>Public-Key Cryptography and Discrete Logarithms: Introduction, ElGamal Cryptosystem, Shanks' Algorithm, Pollard Rho Discrete Logarithm Algorithm, Finite Fields, Elliptic Curves, Discrete Logarithm Algorithms in Practice, Security of ElGamal Systems</p> <p>Signature Schemes: Introduction to RSA Signature</p>	15

		Scheme, Security Requirements, ElGamal Signature Scheme, Variants of the ElGamal Signature Scheme, Full Domain Hash, Certificates, Signing and Encrypting Identification Schemes and Entity Authentication: Passwords and Secure Identification Schemes, Challenge-and-Response in the Secret-key Setting, Challenge-and-Response in the Public-key Setting, Schnorr Identification Scheme, Feige-Fiat-Shamir Identification Scheme	
IV	Key Management (Skill Enhancement)	Key Distribution: Attack Models and Adversarial Goals, Diffie-Hellman Key Predistribution, Blom Scheme, Key Predistribution in Sensor Networks, Session Key Distribution Schemes-Needham-Schroeder Scheme, Kerberos, Threshold Schemes-Shamir Scheme Key Agreement Schemes: Transport Layer Security (TLS), , Diffie-Hellman Key Agreement, Known Session Key Attacks, Key Derivation Functions, MTI Key Agreement Schemes, Deniable Key Agreement Schemes, Conference Key Agreement Schemes Other Security Issues: Cocks Identity-based Cryptosystem, Copyright Protection, Fingerprinting, Identifiable Parent Property, 2-IPP Codes, Tracing Illegally Redistributed Keys	15

Learning Resources recommended:

TEXTBOOKS:

1. Cryptography Theory and Practice Douglas R. Stinson, , Fourth Edition, CRC Press, 2019
2. Applied Cryptanalysis, Breaking Ciphers in Real World, John Wiley, 2015

REFERENCE BOOKS:

1. Implementing Cryptography, Shannon W. Bray, John Wiley, 2020
2. Algorithmic Cryptanalysis, Antoine Joux, CRC Press, 2017
3. Modern Cryptography: Applied Mathematics for Encryption and Information Security, William Easttom, Springer, 2021

Evaluation Pattern**A. Internal Evaluation:**

Method	Marks
Mid-Term Class Test <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> Assignment / Case Study Report / Presentation can be uploaded on any learning management system. 	10
Attendance	05
Behavior	05

B. Semester End Evaluation (Paper Pattern)

Duration: 2Hours

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

Name of the Course	Practical on Elective-1: Security (Cryptography and Cryptanalysis)
Course Code (refer to student handbook)	PSCSP3021
Class	M.Sc. Computer Science
Semester	III
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: **Practical on Elective-1: Security (Cryptography and Cryptanalysis)**

Course Outcomes:

- To develop the foundation for the study of cryptography and its use in security.
- To understand the application of Number Theory and Algebra for the design of cryptographic Algorithms
- To understand the role of cryptography in communication over an insecure channel.
- To analyze and compare symmetric-key encryption and public-key encryption schemes based on different security models

Curriculum:

Course Code	Course Title	Credits
PSCSP3021	Practical on Elective-1: Security (Cryptography and Cryptanalysis)	02
Note: Following practical can be performed on Netbeans or any other java IDE Minimum 8 Practicals need to submitted as Journal work.		
1	Program to implement password salting and hashing to create secure passwords.	
2	Program to implement various classical ciphers-Substitution Cipher, Vigenère Cipher, and Affine cipher.	
3	Program to demonstrate cryptanalysis (e.g., breaking Caesar or Vigenere Cipher).	
4	Program to implement AES algorithm for file encryption and decryption.	
5	Program to implement various block cipher modes.	
6	Program to implement Steganography for hiding messages inside the image file.	
7	Program to implement HMAC for signing messages.	
8	Program to implement Sending Secure Messages Over IP Networks.	
9	Program to implement RSA encryption/decryption.	
10	Program to implement (i) El-Gamal Cryptosystem (ii) Elliptic Curve Cryptography.	

Evaluation Pattern

A. Internal Evaluation : 20 Marks

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

B. Semester End Evaluation (Paper Pattern): 30 Marks

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

Name of the Course	Security (Cyber Security and Risk Assessment)
Course Code (refer to student handbook)	PSCS3022
Class	M.Sc. Computer Science
Semester	III
No of Credits	04
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: Security (Cyber Security and Risk Assessment)

Course Outcomes:

- Learn about an advanced concept related to penetration testing
- Use of Kali Linux in performing penetration tests against networks, systems, and applications
- Understand ways to protect system and digital assets
- selecting the most effective tools, to rapidly compromising network security to highlighting the techniques used to avoid detection

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Introduction to Penetration Testing and Reconnaissance	<p>Goal-based penetration testing: Introduction to Penetration Testing, Different types of threat actors, Conceptual overview of security testing, Common pitfalls of vulnerability assessments, penetration testing, and red team exercises, Objective-based penetration testing, The testing methodology Kali Linux & Red Team Tactics, Using CloudGoat and Faraday Open-source Intelligence and Reconnaissance: Basic Principles of Reconnaissance, Scraping, Google Hacking Database, creating custom wordlist for cracking password</p> <p>Active Reconnaissance of External and Internal Networks: Stealth scanning techniques, DNS reconnaissance, and route mapping, Employing comprehensive reconnaissance applications, Identifying the external network infrastructure, Mapping beyond the firewall, IDS/IPS identification, Enumerating hosts, port, operating system, and service discovery, Writing your port scanner using netcat, Large-scale scanning, Machine Learning for Reconnaissance</p>	15
II	Vulnerabilities and Advanced Attacks	<p>Vulnerability Assessment: Local and online vulnerability databases, Vulnerability scanning with Nmap, Web application vulnerability scanners, Vulnerability scanners for mobile applications, OpenVAS network vulnerability scanner, Commercial vulnerability scanners, Specialized scanners, Threat modeling</p> <p>Advanced Social Engineering and Physical Security: Common Methodology, Physical attacks at a console, creating rough physical devices, Social Engineering Toolkit, Hiding executables and obfuscating the attacker's URL, Escalating an attack using DNS redirection, Launching Phishing attack</p> <p>Wireless and Bluetooth Attacks: Wireless reconnaissance, Bypassing open SSID and MAC address authentication, attacking WPA and WPA2, Dos attacks against Wireless communication, Compromising enterprise implementations of WPA2, Evil Twin attack, using bettercap, WPA3, Bluetooth attacks</p>	15
III	Web and Cloud	Exploiting Web-based applications: Web app Hacking	15

	Exploitations	methodology, Reconnaissance of web apps, client-side proxies, application-specific attacks, Browser exploitation Framework Cloud Security Exploitation: Vulnerability scanning and application exploitation, Testing S3 bucket misconfiguration, exploiting security permission flaws, obfuscating Cloudtail logs Bypassing Security Controls: Bypassing Network Access Control and application-level controls, Bypassing antivirus, Bypassing Windows OS controls	
IV	Exploiting System Vulnerabilities (Skill Enhancement)	Metasploit Exploitation: Metasploit framework, exploiting single and multiple targets using MSF, using the public exploit, developing windows exploit Privilege Escalation: Escalation methodology, escalating from domain user to system administrator, local system escalation, escalating from administrator to system, credential harvesting, and escalating attacks, escalating access right in active directory Embedded devices and RFID Hacking: Firmware unpacking and updating, Introduction to RouterSploit Framework, UART, Cloning RFID using ChameleonMini	15

Learning Resources recommended:

TEXTBOOKS:

1. Mastering Kali Linux for Advanced Penetration Testing Fourth Edition, Vijay Kumar Velu, Packt, 2022
2. Learn Kali Linux 2019: Perform Powerful Penetration Testing Using Kali Linux, Metasploit, Nessus, Nmap, And Wireshark, Glen D. Singh, Packt, 2019

Evaluation Pattern**A. Internal Evaluation:**

Method	Marks
Mid-Term Class Test <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> Assignment / Case Study Report / Presentation can be uploaded on any learning management system. 	10
Attendance	05
Behavior	05

B. Semester End Evaluation (Paper Pattern)

Duration: 2Hours

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

Name of the Course	Practical Course on Elective-2: Security (Cyber Security and Risk Assessment)
Course Code (refer to student handbook)	PSCSP3022
Class	M.Sc. Computer Science
Semester	III
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: **Practical Course on Elective-2: Security (Cyber Security and Risk Assessment)**

Course Outcomes:

- Learn about an advanced concept related to penetration testing
- Use of Kali Linux in performing penetration tests against networks, systems, and applications
- Understand ways to protect system and digital assets
- Selecting the most effective tools, to rapidly compromising network security to highlighting the techniques used to avoid detection.

Curriculum:

Course Code	Course Title	Credits
PSCSP3022	Practical Course on Elective-2: Security (Cyber Security and Risk Assessment)	02
Note: Following practical can be performed on Kali linux and metasploitable OS Minimum 8 Practicals need to submitted as Journal work.		
1	Exploring and building a verification lab for penetration testing (Kali Linux)	
2	Use of open-source intelligence and passive reconnaissance	
3	Practical on enumerating host, port, and service scanning	
4	Practical on vulnerability scanning and assessment	
5	Practical on use of Social Engineering Toolkit	
6	Practical on Wireless and Bluetooth attacks	
7	Practical on Exploiting Web-based applications	
8	Practical on using Metasploit Framework for exploitation.	
9	Practical on injecting Code in Data Driven Applications: SQL Injection	
10	Wireless Network threats (sniff wifi hotspots, analyze strength, discover wireless access points)	

Evaluation Pattern

A. Internal Evaluation : 20 Marks

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

B. Semester End Evaluation (Paper Pattern): 30 Marks

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

Name of the Course	Computer Networking (Server and Data-Centric Networking)
Course Code (refer to student handbook)	PSCS3031
Class	M.Sc. Computer Science
Semester	III
No of Credits	04
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: **Computer Networking (Server and Data-Centric Networking)**

Course Outcomes:

- Identify important requirements to design and support a data center.
- Determine a data center environment's requirements including systems and network architecture as well as services.
- Evaluate options for server farms, network designs, high availability, load balancing, data center services, and trends that might affect data center designs.
- Design a data center infrastructure integrating features that address security, performance, and availability.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Virtualization History and Definitions	<p>Data Center: Essential Definition, Data Center Evolution, thernet Protocol, The Humble Beginnings of Network Virtualization,Resource Sharing Control and Management Plane, Concepts from the Routing World, Overlapping Addresses in a Data Center</p> <p>Virtual Routing and Forwarding:Defining and Configuring VRFs, VRFs and Routing Protocols, VRFs and the Management Plane VRF-Awareness, VRF Resource Allocation Control, Use Case: Data Center Network Segmentation</p>	15
II	ACE Virtual Context	<p>Application Networking Services: The Use of Load Balancers, Load-Balancing Concepts, Security Policies, Suboptimal Traffic, Application Environment Independency, ACE Virtual Contexts, Application Control Engine Physical Connections, Connecting an ACE Appliance, Bridged Design, One-Armed Design,</p> <p>Managing and Configuring ACE: Virtual Contexts, Allowing Management Traffic to a Virtual Context, Allowing Load Balancing Traffic Through a Virtual Context, Controlling Management Access to Virtual Contexts, ACE Virtual Context Additional Characteristics, Sharing VLANs Among Contexts, Virtual Context Fault Tolerance, Instant Switches, MPLS Basic Concepts</p>	15
III	Virtualization in Server Technologies	<p>Server virtualization: Operational Policies, Configuration, External IPMI Management Configuration, Management IP Address, The Virtual Data Center and Cloud Computing, The Virtual Data Center</p> <p>Automation and Standardization: Cloud Implementation Example, Journey to the Cloud, Networking in the Clouds, Software-Defined Networks, OpenStack, Network Overlays</p>	15
IV	Intelligent Disk Subsystems (Skill Enhancement)	<p>Disk Subsystem: The architecture of Intelligent Disk Subsystems Hard Disks and Internal I/O Channels</p> <p>JBOD: The Physical I/O Path from the CPU to the Storage System, SCSI, Fibre Channel SAN, SCSI via InfiniBand and RDMA,Fibre Channel over Ethernet (FCoE) I/O Consolidation based on Ethernet,FCoE Details,Data Center Bridging (DCB), File Systems and</p>	15

	Network Attached Storage (NAS) File system Management: Local File Systems File systems and databases Journaling;, Snapshots Volume	
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Learning Resources recommended:**TEXTBOOKS:**

1. Data Center Virtualization Fundamentals by Gustavo Alessandro Andrade Santana, Cisco Press, 2018
2. Storage Networks Explained Wiley Publishing, 2019

REFERENCE BOOKS:

1. Information Storage and Management Wiley Publishing, 2016
2. Storage Networks: The Complete Reference, 2019

Evaluation Pattern**A. Internal Evaluation:**

Method	Marks
Mid-Term Class Test <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • Assignment / Case Study Report / Presentation can be uploaded on any learning management system. 	10
Attendance	05
Behavior	05

B. Semester End Evaluation (Paper Pattern)

Duration: 2Hours

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

Name of the Course	Practical Course on Elective-1: Computer Networking (Server and Data-Centric Networking)
Course Code (refer to student handbook)	PSCSP3031
Class	M.Sc. Computer Science
Semester	III
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: Practical Course on Elective-1: Computer Networking (Server and Data-Centric Networking)

Course Outcomes:

- Identify important requirements to design and support a data center.
- Determine a data center environment's requirements including systems and network architecture as well as services.
- Evaluate options for server farms, network designs, high availability, load balancing, data center services, and trends that might affect data center designs.
- Design a data center infrastructure integrating features that address security, performance, and availability.

Curriculum:

Course Code	Course Title	Credits
PSCSP3031	Practical Course on Elective-1: Computer Networking (Server and Data-Centric Networking)	02
Note: Practical can be implemented using GNS3, CISCO packet tracer 7.0 and above Minimum 8 Practicals need to submitted as Journal work.		
01	Installation of <ul style="list-style-type: none"> • Vmware Esxi • Citrix Xen • Microsoft Hyper-V 	
02	Create and manage the inter connectivity of Virtual Machine on <ul style="list-style-type: none"> • Vmware Esxi • Citrix Xen • Microsoft Hyper-V 	
03	Configuring Trunks between switches and VTP Pruning Suggested Topology	
04	Configuring EtherChannels Suggested Topology	
05	<ul style="list-style-type: none"> • Configure Secure DMVPN Tunnels • Implement a DMVPN Phase 1 Hub-to-Spoke Topology • Implement a DMVPN Phase 3 Spoke-to-Spoke Topology 	

06	<ul style="list-style-type: none"> ● Implement BGP Path Manipulation ● Implement BGP Communities
07	<ul style="list-style-type: none"> ● Control Routing Updates ● Path Control Using PBR
08	<ul style="list-style-type: none"> ● Implement Route Redistribution Between Multiple Protocols ● Configure Route Redistribution Within the Same Interior Gateway Protocol
09	<ul style="list-style-type: none"> ● Implement GLBP ● Implement VRRP ● Implement HSRP
10	Implement MPLS

Evaluation Pattern

A. Internal Evaluation : 20 Marks

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

B. Semester End Evaluation (Paper Pattern): 30 Marks

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

Name of the Course	Computer Networking (Wireless Networking)
Course Code (refer to student handbook)	PSCS3032
Class	M.Sc. Computer Science
Semester	III
No of Credits	04
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: **Computer Networking (Wireless Networking)**

Course Outcomes:

- To understand basic concepts of wireless networking.
- To understand 4G, 5G Technologies and their working.
- To implement Wireless architecture practically.
- To gain knowledge about sensors and their working.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Basic Principles of Wireless Networking	<p>Introduction to Wireless Sensor Networks: Terminologies, Advantages, Challenges and Applications, Types of wireless sensor networks. 15L</p> <p>Wireless Communication Technologies: Mobile Ad-hoc Networks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks</p>	15
II	Wireless Optical Communication(WOC)	<p>Optical Communication: Introduction to wireless optical communication (WOC), wireless optical channels, atmospheric channel, underwater optical channel, atmospheric losses</p> <p>WOC and Applications: Weather condition influence, atmospheric turbulence effects i.e. scintillation, beam spreading, etc. wireless optical communication application areas, WOC challenges and applications</p>	15
III	Fourth Generation Systems and New Wireless Technologies	<p>4G Vision: 4G Features and Challenges, Applications of 4G; 4G Technologies - LTE FDD vs TDD comparison; frame structure and its characteristics; Smart Antenna Techniques, OFDM</p> <p>Trends in Wireless Technology: MIMO Systems, Adaptive Modulation and Coding with Time-Slot Scheduler - Bell Labs Layered Space Time (BLAST) System , Software-Defined Radio, Cognitive Radio</p>	15
IV	Recent Trends in Wireless Networking (Skill Enhancement)	<p>5G Technology: Understand 5GPP & NGMN, 5G architecture and design objective, 5G spectrum requirements, ITU-R IMT-2020 vision for 5G, 5G RAN & Dynamic CRAN</p> <p>Architecture and applications: 5G Mobile Edge Computing & Fog computing, 5G Protocol Stack, 5G Ultra-dense networks, 5G Air interface, Applications</p>	15

Learning Resources recommended:

TEXTBOOK:

1. Anurag Kumar, D.Manjunath, Joykuri, —Wireless Networking, third Edition, Elsevier 2018.

REFERENCE BOOKS:

1. Jochen Schiller, Mobile Communications, Second Edition, Pearson Education 2019.
2. Vijay Garg, —Wireless Communications and networking, First Edition, Elsevier 2012.

Evaluation Pattern

A. Internal Evaluation:

Method	Marks
Mid-Term Class Test <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • Assignment / Case Study Report / Presentation can be uploaded on any learning management system. 	10
Attendance	05
Behavior	05

B. Semester End Evaluation (Paper Pattern)

Duration: 2Hours

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

Name of the Course	Practical Course on Elective-2: Computer Networking (Wireless Networking)
Course Code (refer to student handbook)	PSCSP3032
Class	M.Sc. Computer Science
Semester	III
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: **Practical Course on Elective-2: Computer Networking (Wireless Networking)**

Course Outcomes:

- To understand basic concepts of wireless networking.
- To understand 4G, 5G Technologies and their working.
- To implement Wireless architecture practically.
- To gain knowledge about sensors and their working.

Curriculum:

Course Code	Course Title	Credits
PSCSP3032	Practical Course on Elective-2: Computer Networking (Wireless Networking)	02
Note: Practical can be implemented using GNS3, CISCO packet tracer 7.0 and above Minimum 8 Practicals need to be submitted as Journal work.		
1	Configuring WEP on a Wireless Router	
2	Demonstrating Distribution Layer Functions	
3	Placing ACLs	
4	Planning Network-based Firewalls	
5	Configure Auto Profiles ACU Utilities	
6	Creating an Adhoc Network	
7	Configuring Basic AP Settings	
8	Configure Ethernet/Fast Ethernet Interface	
9	Configure Radio Interfaces through the GUI	
10	Configure Site-to-Site Wireless Link	

Teaching plan:

Unit	Title	Expected date of completion	Teaching methods
All 4 Units	10 Practical's	Second week of October	Laboratory + ICT

Evaluation Pattern**A. Internal Evaluation : 20 Marks**

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

B. Semester End Evaluation (Paper Pattern): 30 Marks

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

Name of the Course	Data Science (Data Visualization)
Course Code (refer to student handbook)	PSCS3041
Class	M.Sc. Computer Science
Semester	III
No of Credits	04
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: **Data Science (Data Visualization)**

Course Outcomes:

- Familiarity with working with data analysis tools.
- Ability to perform data wrangling for practical purposes.
- Ability to solve real-world data analysis problems with thorough, detailed examples.
- Ability to use Tableau to handle data from various sources and perform analysis of data.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Preparing and Storing Data	<p>Series: Creating a Series with index, creating a Series from a Dictionary, Creating a Series from a Scalar Value, Vectorized Operations and Label Alignment with Series, Name Attribute. Accessing Data from a Series with a Position, Exploring and Analyzing a Series, Operations on a Series.</p> <p>Data Frames: Creating a Data Frame from a Dict of Series or Dicts, Creating Data Frames from a Dict of Ndarrays, Creating Data Frames from a Structured or Record Array, Creating Data Frames from a List of Dicts, Creating Data Frames from a Dict of Tuples, Selecting, Adding, and Deleting Data Frame Columns, Assigning New Columns in Method Chains, Row Selection, Row Addition, Row Deletion, Exploring and Analysing a Data Frame, Indexing and Selecting Data Frames, Transposing a Data Frame, Data Frame Interoperability with Numpy Functions.</p> <p>Visualizing Data: Data visualization in Business Intelligence, Data visualization techniques. Data visualization libraries in Python</p>	15
II	Data Cleaning and Data Wrangling	<p>Data Gathering and Cleaning: Cleaning Data, Checking for Missing Values, Handling the Missing Values, Reading and Cleaning CSV Data, Merging and Integrating Data, Reading Data from the JSON Format, HTML Format, XML Format.</p> <p>Data Transformation Removing Duplicates: Replacing Values, Renaming Axis Indexes</p> <p>Hierarchical Indexing: Reordering and Sorting Levels</p> <p>Summary' Statistics by Level Indexing with a DataFrame's columns. Combining and Merging Datasets Database-Style, DataFrame Joins Merging on Index Concatenating Along with an Axis Combining Data with Overlap</p> <p>Reshaping and Pivoting: Reshaping with Hierarchical Indexing Pivoting —Long to —Widel Format Pivoting —Widel to —Long Format.</p> <p>Statistical Analysis, Data Aggregation: Data Grouping, Iterating Through Groups, Aggregations, Transformations, Filtration.</p>	15
III	Basics of	Tableau: Introduction, connecting to data, Visualizing	15

	Tableau	Data using Tableau, Graphs, charts, and reports Connecting to Data: Connecting various data sources, Managing data source metadata, Extract Data, Filtering data. Moving beyond basic visualization. Calculations: Introduction to Calculation, Row-level Calculations, Aggregate calculations, parameters, Leveraging level of Detail Calculations. Telling Data Story with Dashboards: Designing Dashboards in tableau, Designing for different displays and devices.	
IV	Visual Analytics (Skill Enhancement)	Trends: Trend Models, Analyzing Trend Models. Clustering, Distributions, and Forecasting. Advanced visualization: Different Charts and Visualization. Dynamic Dashboards: Sheet Swapping, Automatically Showing and hiding controls. Exploring Mapping and Advanced Geospatial Features: Rendering maps with Tableau. Using Geospatial Data Creating custom territories. Structuring Messy Data to Work Well in Tableau: Structuring data for Tableau. Taming data with Tableau Prep: Cleaning, Transforming, Filtering, and Calculating data. Sharing Data story.	15

Learning Resources recommended:**TEXTBOOKS:**

1. Dr. Ossama Embarak, Data Analysis and Visualization Using Python, Apress, 2018
2. Wes McKinney, —Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, O'Reilly, 2nd Edition, 2018.
3. Learning Tableau 2020, Create effective data visualizations, build interactive visual analytics, and transform your organization. Joshua Milligan, Fourth Edition, Packt, 2020.

REFERENCE BOOKS:

1. Jake VanderPlas, —Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly, 2017
2. Visual Data Storytelling with Tableau, Linda Ryan, Pearson Addison Wesley Data & Analytics Series, 2018
3. Visual Analytics with Tableau, Alexander Loth, Wiley, 2019

Evaluation Pattern**A. Internal Evaluation**

Method	Marks
Mid-Term Class Test <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> Assignment / Case Study Report / Presentation can be uploaded on any learning management system. 	10
Attendance	05
Behavior	05

B. Semester End Evaluation (Paper Pattern)

Duration: 2Hours 30Minutes

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

Name of the Course	Practical Course on Elective-1: Data Science (Data Visualization)
Course Code (refer to student handbook)	PSCSP3041
Class	M.Sc. Computer Science
Semester	III
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: **Practical Course on Elective-1: Data Science (Data Visualization)**

Course Outcomes:

- Familiarity with working with data analysis tools.
- Ability to perform data wrangling for practical purposes.
- Ability to solve real-world data analysis problems with thorough, detailed examples.
- Ability to use Tableau to handle data from various sources and perform analysis of data.

Curriculum:

Course Code	Course Title	Credits
PSCSP3011	Practical Course on Elective-1: Data Science (Data Visualization)	02
Note: Practical can be implemented using Python / R studio.		
Minimum 8 Practicals need to submitted as Journal work.		
1	Create one-dimensional data using series and perform various operations on it.	
2	Create Two-dimensional data with the help of data frames and perform different operations on it.	
3	Write a code to read data from the different file formats like JSON, HTML, XML, and CSV files and check for missing data and outlier values and handle them.	

4	Perform Reshaping of the hierarchical data and pivoting data frame data.
5	Connecting and extracting with various data resources in tableau.
6	Performing calculations and creating parameters in Tableau.
7	Designing Tableau Dashboards for different displays and devices.
8	Create a Trend model using data, Analyse-it and use it for forecasting.
9	Creating Geospatial feature maps in Tableau using Geospatial Data.
10	Create Dashboard and Storytelling using tableau.

Evaluation Pattern

A. Internal Evaluation : 20 Marks

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

B. Semester End Evaluation (Paper Pattern): 30 Marks

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

Name of the Course	Data Science (Big Data Analytics)
Course Code (refer to student handbook)	PSCS3042
Class	M.Sc. Computer Science
Semester	III
No of Credits	04
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: Data Science (Big Data Analytics)

Course Outcomes:

- Exposure to the fundamentals of business intelligence and big data analytics.
- Understand basic concepts in Big Data analytics and parallel data processing.
- Understand Hadoop Technology and its applications.
- Exposure to real-life applications and solving them using big data toolkits.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Big Data and Hadoop	<p>Big Data: Characteristics of Big Data, Big Data importance, and Applications, Big Data Analytics, Typical Analytical Architecture, Requirement for new analytical architecture, Challenges in Big Data Analytics, Need of big data frameworks, Types and Sources of Big Data. Exploring the Use of Big Data in Business Context</p> <p>Hadoop Framework: Requirement of Hadoop Framework, Design principle of Hadoop, Hadoop Components, Hadoop Ecosystem, Hadoop 2 architecture, Hadoop YARN Architecture, Advantage of YARN, YARN Command. HDFS: Design of HDFS, Benefits and Challenges, HDFS Commands.</p>	15
II	Map Reduce and HBASE	<p>MapReduce Framework and Basics: Working of Map Reduce, Developing Map Reduce Application, I/O formats, Map side join, Reduce Side Join, Secondary sorting, Pipelining MapReduce jobs. Processing data using Map Reduce.</p> <p>HBASE: Role of HBase in Big Data Processing, Features of HBase. HBase Architecture, Zookeeper. HBase Commands for creating, listing, and Enabling data tables</p>	15
III	Spark	<p>Spark Framework: Overview of Spark, Hadoop vs Spark, Cluster Design, Cluster Management, performance, Application Programming Interface (API): Spark Context, Resilient Distributed Datasets, Creating RDD, RDD Operations, Saving RDD - Lazy Operation, Spark Jobs.</p> <p>Writing Spark Application – Compiling and Running the Application. Monitoring and debugging Applications. Spark Programming.</p>	15
IV	Data Analysis using Spark (Skill Enhancement)	<p>Spark SQL: SQL Context, Importing and Saving data, Data frames, using SQL, GraphX overview, Creating Graph, Graph Algorithms.</p> <p>Spark Streaming: Overview, Errors and Recovery, Streaming Source, Streaming live data with spark</p> <p>Hive: Hive services, Data Types, and Built-in functions in Hive.</p> <p>Pig: Working with operators in Pig, Working with Functions and Error Handling in Pig</p> <p>Flume and Sqoop: Flume Architecture, Sqoop,</p>	15

	Importing Data. Sqoop2 vs Sqoop.	
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Learning Resources recommended:**TEXTBOOKS:**

1. Big Data Analytics, Introduction to Hadoop, Spark, and Machine-Learning, Raj Kamal, Preeti Saxena, McGraw Hill, 2019
2. Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization, Dreamtech Press; 1st edition, 2016
3. Big Data Analytics with Spark, A Practitioner's Guide to Using Spark for Large Scale Data Analysis, Apress, 2015
1. Hadoop MapReduce v2 Cookbook - Second Edition, Packt Publishing, 2015

REFERENCE BOOKS:

1. Big Data in Practice: How 45 Successful Companies Used Big Data Analytics to Deliver Extraordinary Results, Wiley, 1st edition, 2016
2. Hadoop – TheDefinitive Guide by Tom White, OReilly, 2012
3. Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data, McGrawHill, 2012
4. Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Michael Minelli, Wiley, 2013

Evaluation Pattern**A. Internal Evaluation:**

Method	Marks
Mid-Term Class Test <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • Assignment / Case Study Report / Presentation can be uploaded on any learning management system. 	10
Attendance	05
Behavior	05

B. Semester End Evaluation (Paper Pattern)

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	<i>Objective Based</i>	12
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Name of the Course	Practical Course on Elective-2: Data Science (Big Data Analytics)
Course Code (refer to student handbook)	PSCSP3042
Class	M.Sc. Computer Science
Semester	III
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: Practical Course on Elective-2: Data Science (Big Data Analytics)

Course Outcomes:

- Exposure to the fundamentals of business intelligence and big data analytics.
- Understand basic concepts in Big Data analytics and parallel data processing.
- Understand Hadoop Technology and its applications.
- Exposure to real-life applications and solving them using big data toolkits.

Curriculum:

Course Code	Course Title	Credits
PSCSP3042	Practical Course on Elective-2: Data Science (Big Data Analytics)	02
Note: Following practical can be performed on Hadoop, Map Reduce, Java and HBase. Minimum 8 Practicals need to submitted as Journal work.		
1	Installing and setting environment variables for Working with Apache Hadoop.	
2	Implementing Map-Reduce Program for Word Count problem,	
3	Download and install Spark. Create Graphical data and access the graphical data using Spark.	
4	Write a Spark code for the given application and handle error and recovery of data.	
5	Write a Spark code to Handle the Streaming of data.	

6	Install Hive and use Hive Create and store structured databases.
7	Install HBase and use the HBase Data model Store and retrieve data.
8	Perform importing and exporting of data between SQL and Hadoop using Sqoop.
9	Write a Pig Script for solving counting problems.
10	Use Flume and transport the data from the various sources to a centralized data store.

Evaluation Pattern

A. Internal Evaluation : 20 Marks

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

B. Semester End Evaluation (Paper Pattern): 30 Marks

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

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

Name of the Course	Robotics (Online Mode)
Course Code (refer to student handbook)	PSCS401
Class	M. Sc. Computer Science
Semester	IV
No of Credits	4
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: **Robotics (Online Mode)**

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:

Unit	Title	Learning Points	No of Lectures
UNIT 1	Introduction to Robotics	Introduction to Robotics: What is a robot? Examples of Advanced and impressive robots, Robots in the home, Robots in industry Robotics in Action: Exploring Robot Building Blocks - Code and Electronics Technical requirements, Introducing the Raspberry Pi - Starting with Raspbian Technical requirements, Raspberry Pi controller on a robot	15
UNIT 2	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 behavior, and Programming RGB Strips in robot	15
UNIT 3	Servo 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 behavior. Creating a menu to select different robot behaviors, Distance and speed measuring sensors—encoders and odometry	15
UNIT 4	Robot Vision and Voice Communication	Robotics setup: 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	15

		Robotics for Vision and Voice Applications: Colors, masking, and filtering – chasing colored objects, Detecting faces with Haar cascades, Finding objects in an image, Voice Communication with a robot	
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Learning Resources recommended:**TEXTBOOKS:**

1. Danny Staple, Robotics Programming, Packt Publishing, 2nd edition, Feb 2021

REFERENCE BOOKS:

1. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, Wiley, 3rd Edition, 2019
2. D. K. Pratihari, FUNDAMENTALS OF ROBOTICS. Narosa Publication, 2016
3. Lentin Joseph, Learning Robotics Using Python, Packt Publishing Ltd., May 2015

Evaluation Pattern**A. Internal Evaluation:**

Method	Marks
Mid-Term Class Test <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • Assignment / Case Study Report / Presentation can be uploaded on any learning management system. 	10
Attendance	05
Behavior	05

B. Semester End Evaluation (Paper Pattern)

Duration: 2Hours

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

Name of the Course	Practical Course on Robotics (Online Mode)
Course Code (refer to student handbook)	PSCSP401
Class	M. Sc. Computer Science
Semester	IV
No of Credits	4
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: Robotics (Online Mode)

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
PSCSP401	Practical Course on Robotics (Online Mode)	02
Note: Following practical can be performed using Python and simulators, Raspberry Pi, and other hardware devices.		
Minimum 8 Practicals need to 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 behavior 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 behaviors.	
12	Use a Raspberry Pi to run the Mycroft environment and connect it to a speaker/microphone combination	

Evaluation Pattern

A. Internal Evaluation : 20 Marks

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

B. Semester End Evaluation (Paper Pattern): 30 Marks

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

Name of the Course	Advanced Deep Learning (Online Mode)
Course Code (refer to student handbook)	PSCS402
Class	M. Sc. Computer Science
Semester	IV
No of Credits	4
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: Advanced Deep Learning (Online Mode)

Course Outcomes:

- Understand the context and use of neural networks and deep learning
- Understand the tools and libraries for deep learning
- Have a working knowledge of neural networks and deep learning
- Explore the parameters for neural networks
- Identify emerging applications of deep learning

Curriculum:

Unit	Title	Learning Points	No of Lectures
UNIT 1	Neural Network for Deep Learning	Optimization and Neural Network: Review of Neural Network fundamentals, the problem of Learning, Implementing single Neuron-Linear and Logistic Regression, Deep Learning: Fundamentals, Deep Learning Applications, Popular open-source libraries for deep learning Feed-Forward Networks: Networks architecture and Matrix notation, Overfitting, Multiclass Classification with Feed-Forward Neural Networks, Estimating Memory requirement of Models	15L
UNIT 2	Convolutional and Recurrent Networks for Deep Learning	Regularization: Complex Network and Overfitting, Regularization and related concepts, Hyperparameter tuning Convolutional Neural Networks:Kernels and Filters,Building Blocks of CNN, Inception Network, Transfer Learning Recurrent Neural Network: Notation and Idea of recurrent neural networks, RNN Topologies, backpropagation through time, vanishing and exploding gradients	15L
UNIT 3	Advanced Concepts for Deep Learning	Autoencoders: Introduction, Network Design, Regularization in Autoencoders, Denoising autoencoders, Feed-Forward Autoencoders, sparse and Contractive autoencoders Unsupervised Feature Learning: Hopfield networks and Boltzmann machines, restricted Boltzmann machine, Deep belief networks Generative Adversarial Networks (GANs):Introduction, training algorithms, Conditional GANs, applications, Deep convolutional generative adversarial networks	15L
UNIT 4	Deep Learning	Deep Learning for AI Games: AI Game	15L

	Application	<p>Playing, Reinforcement learning, Maximizing future rewards, Q-learning, The deep Q-network as a Q-function, Balancing exploration with exploitation, Experience replay, or the value of experience</p> <p>Deep Learning for Object Localization and classification: Intersect Over Union (IoU), Sliding Window Approach, Region-Based CNN (R-CNN)</p> <p>Deep Learning for Language Modelling and Speech Recognition</p>	
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Learning Resources recommended:

TEXTBOOKS:

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

REFERENCE BOOKS:

1. Advanced Deep Learning with Keras, Rowel Atienza, Packt Publication, 2018
2. Python Deep Learning Cookbook, Indra den Bakker, Packt Publication, 2017
3. Deep Learning with Keras, Antonio Gulli, Packt Publication, 2017

Evaluation Pattern**A. Internal Evaluation:**

Method	Marks
Mid-Term Class Test <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> Assignment / Case Study Report / Presentation can be uploaded on any learning management system. 	10
Attendance	05
Behavior	05

B. Semester End Evaluation (Paper Pattern)

Duration: 2Hours

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

Name of the Course	Advanced Deep Learning (Online Mode)
Course Code (refer to student handbook)	PSCSP402
Class	M. Sc. Computer Science
Semester	IV
No of Credits	4
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: **Advanced Deep Learning (Online Mode)**

Course Outcomes:

- Understand the context and use of neural networks and deep learning
- Understand the tools and libraries for deep learning
- Have a working knowledge of neural networks and deep learning
- Explore the parameters for neural networks
- Identify emerging applications of deep learning

Curriculum:

Course Code	Course Title	Credits
PSCSP402	Practical Course on Advanced Deep Learning (Online Mode)	02
Note: Following practical can be performed using python Minimum 8 Practicals need to be submitted as Journal work.		
1	Implement Feed-forward Neural Network and train the network with different optimizers and compare the results.	
2	Write a Program to implement regularization to prevent the model from overfitting	
3	Implement deep learning for recognizing classes for datasets like CIFAR-10 images for previously unseen images and assign them to one of the 10 classes.	
4	Implement deep learning for the Prediction of the autoencoder from the test data (e.g. MNIST data set)	
5	Implement Convolutional Neural Network for Digit Recognition on the MNIST Dataset	
6	Write a program to implement Transfer Learning on the suitable dataset (e.g. classify the cats versus dogs dataset from Kaggle).	
7	Write a program for the Implementation of a Generative Adversarial Network for generating synthetic shapes (like digits)	
8	Write a program to implement a simple form of a recurrent neural network. a. E.g. (4-to-1 RNN) to show that the quantity of rain on a certain day also depends on the values of the previous day b. LSTM for sentiment analysis on datasets like UMICH SI650 for similar.	
9	Write a program for object detection from the image/video.	
10	Write a program for object detection using pre-trained models to use object detection.	

Evaluation Pattern

A. Internal Evaluation : 20 Marks

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

B. Semester End Evaluation (Paper Pattern): 30 Marks

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

Course Code	Course Title	Credits
PSCSP403	Internship with Industry	06

Context:

An internship offers an environment for the student to apply what he or she has learned in the classroom in a real-world setup. It also equips the student with the technical and non-technical skills required by the industry. An organization, in turn, gets an opportunity to understand and appreciate the curriculum of the program and will be in a position to offer constructive feedback on the course and industry requirements. Faculty will get first-hand exposure to understand the industry and the type of work they do, which will help to improve the pedagogy and delivery.

Internship details:

- Internship should be done in a registered organization.
- Internship should be of 2 to 3 months with 8 to 12 weeks duration.
- The student is expected to devote at least 300 hours physically at the organization.
- The student is expected to find an internship by himself or herself. However, the institution should assist their students in getting an internship in good organizations.
- The home institution cannot be taken as the place of internship.
- Internship can be on any topic covered in the syllabus.

Interning organization: Internship can be done, in one of the following, but not restricted to, types of organizations:

- Software development firms
- Hardware/ manufacturing firms
- Any small-scale industries, service providers like banks
- Clinics/ NGOs/professional institutions like that of CA, Advocate, etc
- Civic Depts like Ward office/post office/police station/ panchayat.
- Research Centres/ University Depts/ College as research Assistants for research projects or similar capacities.

Internship mentors:

To ensure the rigor of the MSc program, a student will be provided with a faculty mentor provided by the institution and an industry mentor, to be provided by the organization where the student is interning with.

- The industry mentor ensures that the requirements of the organization and the demands of the project are done by the internee.
- The faculty mentor is the overall in charge of the internship. He or she could evaluate the quality of the internship in a uniform manner across all

students and within the demand of the program.

Documentation of the internship:

The student will make two documents as part of the internship.

- **Online diary:** This ensures that the student updates daily activity, which could be accessed by both the mentors. Daily entry can be of 3- 4 sentences giving a very brief account of the learning/activities/interaction taken place. The faculty mentor will be monitoring the entries in the diary regularly.
- **Internship report:** A student is expected to make a report based on the internship he or she has done in an organization. It should contain the following:
 - **Certificate:** A certificate in the prescribed Proforma (given in appendix 1) from the organization where the internship was done.
 - **Title:** A suitable title giving the idea about what work the student has performed during the internship.
 - **Evaluation form:** The form filled by the supervisor or to whom the intern was reporting, in the prescribed Proforma (given in appendix 2).
 - **Description of the organization:** A small description of the organization where the student has interned
 - **Description of the activities** done by the section where the intern has worked: A description of the section or cell of the organization where the intern worked. This should give an idea about the type of activity a new employee is expected to do in that section of the organization.
 - **Description of work allotted** and done by the intern: A detailed description of the work allotted, and actual work performed by the intern during the internship period. It shall be the condensed and structured version of the daily report mentioned in the online diary.
 - **Self-assessment:** A self-assessment by the intern on what he or she has learned during the internship period. It shall contain both technical as well as interpersonal skills learned in the process.

The internship report needs to be submitted to the external examiner at the time of the University examination.

Interaction between mentors:

To ensure the smooth conduct of the internship a meet-up involving the intern, industry mentor, and the faculty mentor will be scheduled as a mid-term review. The meeting can preferably be online to save time and resources. The meeting ensures the synergy between all stakeholders of the internship. A typical meeting can be of around 15 minutes where at the initial stage the intern briefs about the work and interaction goes for about 10 minutes. This can be followed by the interaction of the mentors in the absence of the intern. This ensures that issues between the intern and the organization, if any, are resolved amicably.

Internship workload for the faculty:

Every student is provided with a faculty member as a mentor. So, a faculty mentor will have a few students under him/her. A faculty mentor is the overall in charge of the internship of the student. He/she constantly monitors the progress of the internship by regularly overseeing the diary, interacting with the industry mentor, and guiding on the report writing etc. Considering the time and effort involved, a faculty mentor who is in-charge of 20 students shall be provided by a workload of 3 hours.

Course Code	Course Title	Credits
PSCSP404	Project Implementation	06

Guidelines for Project Implementation in Semester - IV

- A student is expected to devote at least 3 to 4 months of effort to the implementation.
- Students should submit a detailed project implementation report at the time of viva.

Guidelines for Documentation of Project Proposal in Semester –IV

A student should submit a project implementation report with the following details:

- **Title:** Title of the project.
- **Objective:** A detailed objective of the proposal is needed.
- **Related works:** A detailed survey of the relevant works done by others in the domain. The student is expected to refer to at least 15 recent (last five years) research papers in addition to textbooks and web links in the relevant topic.
- **Methodology:** A proper and detailed procedure of how to solve the problem discussed. It shall contain the techniques, tools, software, and data to be used.
- **Implementation details:** A description of how the project has been implemented.
- **Experimental setup and results:** A detailed explanation of how experiments were conducted, what software was used, and the results obtained. Details like screenshots, tables, and graphs can come here.
- **Analysis of the results:** A description of what the results mean and how they have been arrived at. Different performing measures or statistical tools used etc may be part of this.
- **Conclusion:** A conclusion of the project performed in terms of its outcome
- **Future enhancement:** A small description of what enhancement can be done when more time and resources are available
- **Program code:** The program code may be given as an appendix.

The project documentation needs to be signed by the teacher in charge and head of the Department. Student should also attach the certified copy of the internal evaluation report (Appendix III) at the time of Project evaluation and viva as part of the University examination.

(Seal of the organization)

Appendix-I

(Proforma for the certificate for internship in official letter head)

This is to certify that Mr/Ms _____
of _____ College/Institution worked as an intern
as part of his/her M.Sc. course in Computer Science of University of Mumbai. The
particulars of internship are given below:

Internship starting date: _____

Internship ending date: _____

Actual number of days worked: _____

Tentative number of hours worked: _____ Hours

Broad area of work: _____

A small description of work done by the intern during the period:

Signature: _____

Name: _____

Designation: _____

Contact number: _____

Email: _____

(Seal of the organization)

Appendix-II

(Proforma for the Evaluation of the intern by the industry mentor /to whom the intern was reporting in the organization)

Professional Evaluation of intern

Name of intern: _____ College/institution: _____

[Note: Give a score in the 1 to 5 scale by putting √ in the respective cells]

No	Particular	Excellent	Very Good	Good	Moderate	Satisfactory
1	Attendance & Punctuality					
2	Ability to work in a team					
3	Written and oral communication skills					
4	Problem solving skills					
5	Ability to grasp new concepts					
6	Technical skill in terms of technology, programming etc					
7	Ability to complete the task					
8	Quality of overall work done					

Comments: _____

Signature: _____ Name: _____

Designation: _____ Contact number: _____ Email: _____

(Seal of the organization)

Appendix-III

Maintain the weekly online diary for each week in the following format.

	Day	Date	Name of the Topic/Module Completed	Remarks
WEEK No	MONDAY			
	TUESDAY			
	WEDNESDAY			
	THURSDAY			
	FRIDAY			
	SATURDAY			
	Signature of the Faculty mentor: _____			
Seal of the University/College				

_____XXXX_____



The Chairperson,
BoS of Computer Science