Anekant Education Society's

TuljaramChaturchand College, Baramati

(Autonomous)

Two Year Post Graduate Degree Program in Computer Science

(Faculty of Science & Technology)

CBCS Syllabus

M.Sc. (Computer Science) Part-II Semester -III

For Department of Computer Science

Tuljaram Chaturchand College, Baramati

Choice Based Credit System Syllabus (2023 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2024-2025

(Eligibility: B.Sc. Computer Science)

Title of the Programme: M.Sc. (Computer Science)

<u>Preamble</u>

AES's Tuljaram Chaturchand College has made the decision to change the syllabus of across various faculties from June, 2023 by incorporating the guidelines and provisions outlined in the National Education Policy (NEP), 2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and learning based outcome approach for the development of the students. By establishing a nationally accepted and internationally comparable credit structure and courses framework, the NEP 2020 aims to promote educational excellence, facilitate seamless academic mobility, and enhance the global competitiveness of Indian students. It fosters a system where educational achievements can be recognized and valued not only within the country but also in the international arena, expanding opportunities and opening doors for students to pursue their aspirations on a global scale.

In response to the rapid advancements in science and technology and the evolving approaches in various domains of Computer Science and related subjects, the Board of Studies in Computer Science at Tuljaram Chaturchand College, Baramati - Pune, has developed the curriculum for the first semester of M.Sc.(CS) Part-II Computer Science, which goes beyond traditional academic boundaries. The syllabus is aligned with the NEP 2020 guidelines to ensure that students receive an education that prepares them for the challenges and opportunities of the 21st century. This syllabus has been designed under the framework of the Choice Based Credit System (CBCS), taking into consideration the guidelines set forth by the National Education Policy (NEP) 2020, LOCF (UGC), NCrF, NHEQF, Prof. R.D. Kulkarni's Report, Government of Maharashtra's General Resolution dated 20th April and 16th May 2023, and the Circular issued by SPPU, Pune on 31st May 2023.

A degree in Computer Science subject equips students with the knowledge and skills necessary for a diverse range of fulfilling career paths. Career in Computer Science is

considered one of the most high-paying jobs and is full of opportunities; particularly when India's prowess in information technology industry is recognized across the globe. The pool of talented computer professionals working in IT companies of the USA, Canada and other countries shows that IT can take a person to higher levels. Numerous IT companies from India employ huge number of computer professionals in their Indian and overseas offices. Students who are interested in programming, software development, and have good analytical and reasoning skills may pursue this course. Job opportunities are available for Graduates and Post Graduates in Government as well as Private sector. Graduates may take up the following job posts- Software Engineer, Software Tester, Data Analyst, Project Manager, Network Administrator, database administrator and Application Developer.

Overall, revising the Computer Science syllabus in accordance with the NEP 2020 ensures that students receive an education that is relevant, comprehensive, and prepares them to navigate the dynamic and interconnected world of today. It equips them with the knowledge, skills, and competencies needed to contribute meaningfully to society and pursue their academic and professional goals in a rapidly changing global landscape.

Programme Specific Outcomes (PSOs)
for
M.Sc. (Computer Science)

After completing M.Sc. Computer Science Program students will be able to:

PSO1: Comprehensive Knowledge and Understanding:

Postgraduates will possess a profound understanding of their field, encompassing foundational theories, methodologies, and key concepts within a multidisciplinary context.

PSO2: Practical, Professional, and Procedural Knowledge:

Postgraduates will acquire practical skills and expertise necessary for professional tasks, including industry standards, regulations, and ethical considerations, with effective application in real-world scenarios.

PSO3: Entrepreneurial Mindset, Innovation, and Business Understanding:

Postgraduates will cultivate an entrepreneurial mindset, identify opportunities, foster innovation, and understand business principles, market dynamics, and risk management strategies.

PSO4: Specialized Skills, Critical Thinking, and Problem-Solving:

Postgraduates will demonstrate proficiency in technical skills, analytical abilities, effective communication, and leadership, adapting and innovating in response to changing circumstances.

PSO5: Research, Analytical Reasoning, and Ethical Conduct:

Postgraduates will exhibit observational and inquiry skills, formulate research questions, utilize appropriate methodologies for data analysis, and adhere to research ethics while effectively reporting findings.

PS06: Communication, Collaboration, and Leadership:

Postgraduates will effectively communicate complex information, collaborate in diverse teams, demonstrate leadership qualities, and facilitate cooperative efforts toward common goals.

PS07: Digital Proficiency and Technological Skills:

Postgraduates will demonstrate proficiency in using ICT, accessing information sources, analyzing data using appropriate software, and adapting to technological advancements.

PS08: Multicultural Competence, Inclusive Spirit, and Empathy:

Postgraduates will engage effectively in multicultural settings, respect diverse perspectives, lead diverse teams, and demonstrate empathy and understanding of others' perspectives and emotions.

PS09: Value Inculcation, Environmental Awareness, and Ethical Practices:

Postgraduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and promote sustainability and environmental conservation.

PS010: Autonomy, Responsibility, and Accountability:

Postgraduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts, contributing to societal well-being.

Anekant Education Society's
TuljaramChaturchand College, Baramati
(Autonomous)
Board of Studies (BOS) in Computer Science
From 2022-23 to 2024-25

Sr.No.	Name	Designation
1.	Dr. Upendra Choudhari	Chairman
2.	Dr. Vilas Kardile	Member
3.	Mr. Abhijeet Mankar	Member
4.	Mr. Vishal Shaha	Member
5.	Mrs. Prajakta Kulkarni	Member
6.	Mrs. Asmita Bhagat	Member
7.	Mr. Rahul Shah	Member
8.	Dr. Shashikant Nakate	Member
9.	Mr. Purushottam Dixit	Member
10.	Mr. Swapnil Chemte	Member
11.	Mrs. Kalyani Londhe	Member
12.	Mrs. Poornima Gavimath	Member
13	Dr. Kavita A. Khobragade	Vice-Chancellor Nominee
14	Dr. Sudhakar Bhoite	Expert from other University
15	Dr. Suhas S. Satonkar	Expert from other University
16	Mr. Rohit Shah	Industry Expert
17	Mr. Yogesh More	Meritorious Alumni
18	Mr. Abhijeet Chopade	Student Representative
19	Miss. Rutuja Harihar	Student Representative
20	Mr. Akshada Kulkarni	Student Representative
21	Mr. Prajwal Nimbalkar	Student Representative

CBCS Syllabus 2023 Pattern M.Sc.(CS)- II Sem-III as per NEP 2020

Department of Computer Science, AES's T. C. College (Autonomous), Baramati.

Anekant Education Society's

TuljaramChaturchand College of Arts, Science and Commerce, Baramati

(Autonomous)

Year	Level	Sem.	Major		Research Methodology (RM)	OJT/ FP	RP	Cum. Cr.
			Mandatory	**Electives**				
I	6.0	Sem-I	COS-501-MJM: Principles of Programming Language (**Credit 04**) COS-502-MJM: Cryptography and Cyber Forensics (**Credit 04**) COS-503-MJM: Database Technologies (PR) (**Credit 02**) COS-504-MJM: DotNet (Basic) (PR) (**Credit 02**)	COS-511-MJE(A): Design and Analysis of Algorithms (**Credit04**)	COS-521-RM: Research Methodology in Computer Science (**Credit 04**)	--	--	**20**
		Sem- II	COS-551-MJM: Digital Image Processing (**Credit 04**) COS-552-MJM: Data Mining and Data Warehousing (**Credit 04**) COS-553-MJM: Python Programming-I (Basic) (PR) (**Credit 02**) COS-554-MJM: Dot Net (Advanced) (PR) (**Credit 02**)	COS-561-MJE (A): Artificial Intelligence (**Credit 04**) **OR** COS-561-MJE (B):Advanced Concepts in Operating System. *** 1 Credit = 15 Hr.**	--	COS-581-OJT/FP **Credit 04**	--	**20**
	Cum. Cr.		**24**	**8**	**4**	**4**	**--**	**40**

CBCS Syllabus 2023 Pattern M.Sc.(CS)- II Sem-III as per NEP 2020

Anekant Education Society's

TuljaramChaturchand College of Arts, Science and Commerce, Baramati
(Autonomous)
Credit Distribution Structure for (M.Sc. (Computer Science)) Part-II (2023 Pattern)

Year	Level	Sem.	Major		Research Methodology (RM)	OJT /FP	RP	Cum. Cr.
			Mandatory	**Electives**				
II	6.5	Sem-III	COS-601-MJM: Software Architecture & Design Pattern (**Credit 04**) COS-602-MJM: Machine Learning (**Credit 04**) COS-603-MJM: Web API Using Dot Net Framework (PR) (**Credit 02**) COS-604-MJM: Emerging Technologies- Python Programming. (PR) (**Credit 02**)	COS-611-MJE(A): Data Science & Analytics (**Credit02**) COS-612-MJE(A): Lab Course on COS-611-MJE(A) (**Credit 02**) **OR** COS-611-MJE(A): Soft Computing (**Credit02**) COS-612-MJE(A): Lab Course on COS-611-MJE(B) (**Credit 02**)	COS-621-RM: Research Projects in Computer Science (PR) (**Credit 04**)	--	--	20
		Sem- IV	COS-651-RP: Industrial Training(IT) (**Credit 12**)	COS-652-MJE: Online/MOOC (Elective Course List) (**Credit 2**)	COS-681-MJM: Research Projects in Computer Science (**Credit 6**)	--	--	20
Cum. Cr.			**24**	**6**	**10**	**--**	**--**	**40**

Anekant Education Society's

TuljaramChaturchand College of Arts, Science and Commerce, Baramati (Autonomous)

Course Structure for (M.Sc. (Computer Science) Part-I (2023 Pattern)

Sem	Course Type	Course Code	Title of Course	Theory / Pract.	No. of Credits
I	Major (Mandatory)	COS-501-MJM	Principles of Programming Language	Theory	4
		COS-502-MJM	Cryptography and Cyber Forensics	Theory	4
		COS-503-MJM	Database Technologies	Practical	2
		COS-504-MJM	DotNet (Basic)	Practical	2
	Major (Elective)	COS-511-MJE(A)	Design and Analysis of Algorithms	Theory	4
	RM	COS-521-RM	Research Methodology in Computer Science	Theory	4
			Total Credits:		**20**
II	Major (Mandatory)	COS-551-MJM	Digital Image Processing	Theory	4
		COS-552-MJM	Data Mining and Warehousing	Theory	4
		COS-553-MJM	Basic Python Programming	Practical	2
		COS-554-MJM	Advanced Dot Net	Practical	2
	Major (Elective)	COS-561-MJE (A) OR COS-561-MJE (B)	Artificial Intelligence OR Advanced Concepts in Operating System.	Theory	4
	OJT/FP	COS-581-OJT/FP	On Job Training / Field Projects	Practical	4
			Total Credits:		**20**
			Cumulative Credits of Semester – I and II		**40**

Anekant Education Society's

TuljaramChaturchand College of Arts, Science and Commerce, Baramati (Autonomous)

Course Structure for (M.Sc. (Computer Science) Part-II (2023 Pattern)

Sem	Course Type	Course Code	Title of Course	Theory / Pract.	No. of Credits
III	Major (Mandatory)	COS-601-MJM	Software Architecture & Design Pattern	Theory	4
		COS-602-MJM	Machine Learning	Theory	4
		COS-603-MJM	Web API Using Dot Net Framework	Practical	2
		COS-604-MJM	Emerging Technologies- Python Programming.	Practical	2
	Major (Elective)	COS-611-MJE(A)	Data Science & Analytics	Theory	2
		COS-612-MJE(A)	Lab Course on COS-611-MJE(A)	Practical	2
		OR			
		COS-611-MJE(B)	Soft Computing	Theory	2
		COS-612-MJE(B)	Lab Course on COS-611-MJE(B)	Practical	2
	RM	COS-621-RM	Research Projects in Computer Science	Practical	4
			Total Credits:		**20**
IV	Major (Mandatory)	COS-651-MJM	Industrial Training (IT)	Practical	12
	Major (Elective)	COS-652-MJE	Online/MOOC (Elective Course List)	Theory	2
	Research Project	COS-681-RP	Research Project Work	Practical	6
			Total Credits:		**20**
			Cumulative Credits of Semester – III and IV		**40**

CBCS Syllabus 2023 Pattern M.Sc.(CS)- II Sem-III as per NEP 2020

M.Sc. (Computer Science) – II (Semester – III)

Syllabus

(NEP-2020: 2023 Pattern)

(W.e.f. Academic Year 2022-2023)

SYLLABUS (CBCS as per NEP 2020) FOR M. Sc.-II (Computer Science)
(w. e. f. A.Y 2024-25)

Name of the Programme	:	M.Sc. Computer Science
Program Code	:	PSCS
Class	:	M.Sc. (Computer Science)
Semester	:	III
Course Type	:	Major (Theory)
Course Name	:	Software Architecture & Design Pattern.
Course Code	:	COS-601-MJM
No. of Lectures	:	60
No. of Credits	:	04

Prerequisites:
System Analysis and Design, Software Engineering, OOSE, Software project Management, UML

❖ **Course Objectives:**
1. Mastering architectural concepts to grasp the foundational principles of software architecture.
2. Promoting innovative design thinking to encourage creative problem-solving approaches in software design.
3. Applying design patterns to effectively address common design problems and improve software quality.
4. Understanding trade-offs and constraints to make informed decisions during the software design process.
5. Enhancing collaboration and communication among team members to foster effective teamwork in software development projects.
6. Adopting agile and iterative practices to facilitate flexibility and adaptability in the software development lifecycle.
7. Promoting ethical and responsible design principles to ensure the development of software that aligns with ethical standards and societal values.

❖ **Course Outcomes:**
CO1: Understand Software Architecture Fundamentals.

CO2: Apply Design Patterns Effectively.

CO3: Analyse and Critique Existing Architectures.

CO4: Design and Document Software Architectures.

CO5: Implement and Evaluate Architectural Patterns.

CO6: Collaborate Effectively in Architectural Design.

CO7: Explore Emerging Trends in Software Architecture

Unit	Contents	No of Lectures
1.	**INTRODUCTION TO SOFTWARE ARCHITECTURE** 1.1 Introduction to Software Architecture 1.2 Definition, Architectural structures 1.3 Need and Influence of software architecture in organization as business and technical aspects 1.4 Architecture Business Cycle 1.5 Introduction- Functional requirements, technical constraints, Quality Attributes	04
2.	**QUALITY ATTRIBUTES** 2.1 Introduction Quality Attribute 2.2 Documenting 2.3 Six-part Scenario 2.4 Case Studies	04
3.	**ARCHITECTURE VIEW** 3.1 Introduction, Definition for views 3.2 Structures and views, Representing views, available notations. 3.4 Standard views, 4+1 view of RUP, Siemens 4 views SEI's. perspectives and views 3.4 Case Studies	06
4.	**ARCHITECTURAL STYLES** 4.1 Introduction 4.2 Data flow styles 4.3 Call-return styles with Case study 4.4 Shared Information styles with Case study 4.5 Event styles with Case study	06
5.	**COMMON SOFTWARE ARCHITECTURAL PATTERNS** 5.1 Layered pattern 5.2 Client Server Pattern 5.3 Master-slave pattern 5.4 Pipe-filter pattern 5.5 Broker pattern 5.6 Peer-to-peer pattern 5.7 Event-bus pattern 5.8 Model-view-controller pattern 5.9 Blackboard Pattern 5.10 Interpreter Pattern	12
6.	**Design Pattern** 6.1 Important Design Patterns 6.2 Design Pattern Catalogue, Creational, Structural, and behavioral Patterns. 6.3 Structural Decomposition Organization of Work, Access Control.	10
7.	**DOCUMENTING THE ARCHITECTURE** 7.1 Good practices, Documenting the Views using UML. 7.2 Merits and Demerits of using visual languages.	06

	7.3 Need for formal languages. 7.4 Architectural Description Languages ACME Case studies. Special topics: SOA and Web services, CloudComputing, Adaptive structures	

Reference Books:
- Beyond Software architecture, Luke Hohmann, Addison Wesley, 2003.
- Software architecture, David M. Dikel, David Kane and James R. Wilson, Prentice Hall PTR, 2001
- Software Design, David Budgen, second edition, Pearson education, 2003
- Headfirst Design patterns, Eric Freeman & Elisabeth Freeman, O'REILLY, 2007.
- Design Patterns in Java, Steven John Metsker& William C. Wake, Pearson education, 2006.
- J2EE Patterns, Deepak Alur, John Crupi& Dan Malks, Pearson education, 2003.
- Design Patterns in C#, Steven John Metsker, Pearson education, 2004.
- Pattern Oriented Software Architecture, F. Buschmann& others, John Wiley & Sons
- Anti-Patterns: Refactoring Software, Architectures and Projects in Crisis, William J Brown et al., JohnWiley, 1998
- Object-oriented analysis, design and implementation, brahma Dathan, sarnathrammath, universitiespress,2013
- Design patterns, Erich gamma, Richard Helen, Ralph Johnson, john vlissides ,PEARSONPublication,2013.

Mapping of this course with Programme Outcomes

Course Outcomes	Programme Outcomes (POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	3	2	2	2
CO2	3	3	2	3	3	3	3	2	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	3	3	3	3	2	2	3
CO5	3	3	2	3	3	3	3	2	2	2
CO6	3	3	3	3	3	3	3	3	3	3
CO7	3	2	3	2	3	2	3	2	2	2

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

Justification of PO1 to ALL COs:

CO1:- Comprehensive knowledge and understanding of software architecture fundamentals is directly linked to achieving a holistic understanding of software architecture, which aligns with the overarching goal of comprehensive knowledge and understanding.

CO2:- Applying design patterns effectively is essential in designing and documenting software architectures, which directly contributes to the ability to design and document software architectures effectively.

CO3:- Analyzing and critiquing existing architectures requires a deep understanding of software architecture fundamentals, which is aligned with the goal of understanding software architecture comprehensively.

CO4:- Designing and documenting software architectures necessitates a strong understanding of software architecture fundamentals, directly contributing to comprehensive knowledge and understanding.

CO5:- Implementing and evaluating architectural patterns requires the effective application of design patterns, demonstrating a strong relationship between these two objectives.

CO6:- Collaborating effectively in architectural design demands a solid grasp of software architecture fundamentals, emphasizing the importance of comprehensive knowledge and understanding.

CO7:- Exploring emerging trends in software architecture aligns with the overarching goal of comprehensive knowledge and understanding by staying updated on advancements in the field.

Justification of PO2 to ALL COs:

CO1:- Practical, Professional, and Procedural Knowledge is strongly related to understanding software architecture fundamentals because understanding software architecture requires practical knowledge and procedural understanding to effectively apply architectural concepts in a professional context.

CO2:- Applying design patterns effectively necessitates practical, professional, and procedural knowledge to implement them correctly within software architecture.

CO3:- Analyzing and critiquing existing architectures moderately relates to practical, professional, and procedural knowledge, as it requires a deep understanding of architectural principles and practical experience to provide meaningful critiques.

CO4:- Designing and documenting software architectures strongly relates to practical, professional, and procedural knowledge as it involves the application of such knowledge to create well-designed and documented architectures.

CO5:- Implementing and evaluating architectural patterns strongly relates to practical, professional, and procedural knowledge as it requires the ability to effectively apply these patterns in real-world scenarios and evaluate their effectiveness.

CO6:- Collaborating effectively in architectural design strongly relates to practical, professional, and procedural knowledge as it involves working with others to apply this knowledge in designing software architectures.

CO7:- Exploring emerging trends in software architecture moderately relates to practical, professional, and procedural knowledge as it requires understanding current practices and procedures while being open to new ideas and trends in the field.

Justification of PO3 to ALL COs:

CO1:- Understanding software architecture fundamentals moderately relates to entrepreneurial mindset, innovation, and business understanding as it provides a foundation for making informed decisions regarding software solutions in a business context.

CO2:- Applying design patterns effectively moderately relates to entrepreneurial mindset, innovation, and business understanding as it can contribute to creating innovative solutions that address business needs.

CO3:- Analyzing and critiquing existing architectures moderately relates to entrepreneurial mindset, innovation, and business understanding as it involves assessing how architectures align with business goals and identifying opportunities for improvement and innovation.

CO4:- Designing and documenting software architectures strongly relates to entrepreneurial mindset, innovation, and business understanding as it involves considering business requirements, market needs, and innovation opportunities while designing software solutions.

CO5:- Implementing and evaluating architectural patterns moderately relates to entrepreneurial mindset, innovation, and business understanding as it involves assessing the impact of architectural decisions on business outcomes and seeking innovative ways to improve them.

CO6:- Collaborating effectively in architectural design strongly relates to entrepreneurial mindset, innovation, and business understanding as it involves working with stakeholders to ensure that architectural decisions align with business goals and promote innovation.

CO7:- Exploring emerging trends in software architecture strongly relates to entrepreneurial mindset, innovation, and business understanding as it involves identifying opportunities for innovation and staying ahead of the curve in a rapidly evolving technological landscape.

Justification of PO4 to ALL COs:

CO1:- Understanding software architecture fundamentals strongly relates to specialized skills, critical thinking, and problem-solving as it forms the basis for applying specialized skills to solve complex problems in software design.

CO2:- Applying design patterns effectively strongly relates to specialized skills, critical thinking, and problem-solving as it requires the ability to identify and apply appropriate patterns to solve specific design problems.

CO3:- Analyzing and critiquing existing architectures strongly relates to specialized skills, critical thinking, and problem-solving as it involves evaluating complex systems and identifying areas for improvement through critical analysis and problem-solving.

CO4:- Designing and documenting software architectures strongly relates to specialized skills, critical thinking, and problem-solving as it requires the application of specialized skills to develop effective solutions to complex problems while documenting them for future reference.

CO5:- Implementing and evaluating architectural patterns strongly relates to specialized skills, critical thinking, and problem-solving as it involves applying these skills to implement and assess the effectiveness of architectural patterns in solving specific problems.

CO6:- Collaborating effectively in architectural design strongly relates to specialized skills, critical thinking, and problem-solving as it requires the ability to work with others to solve complex design challenges through critical thinking and problem-solving.

CO7:- Exploring emerging trends in software architecture moderately relates to specialized skills, critical thinking, and problem-solving as it involves critically evaluating new technologies and methodologies to determine their potential impact on software design and problem-solving approaches.

Justification of PO5 to ALL COs:

CO1:-Understanding software architecture fundamentals strongly relates to research and analytical reasoning as it involves analyzing complex architectural concepts and conducting research to deepen understanding.

CO2:-Applying design patterns effectively strongly relates to research, analytical reasoning, and ethical conduct as it requires analyzing various patterns to determine their suitability and considering ethical implications in their application.

CO3:-Analyzing and critiquing existing architectures strongly relates to research, analytical reasoning, and ethical conduct as it involves conducting thorough analysis, reasoning critically, and considering ethical implications in architectural evaluations.

CO4:-Designing and documenting software architectures strongly relates to research, analytical reasoning, and ethical conduct as it involves conducting research to inform design decisions, applying analytical reasoning to solve design problems, and documenting ethically responsible solutions.

CO5:-Implementing and evaluating architectural patterns strongly relates to research, analytical reasoning, and ethical conduct as it involves researching suitable patterns, analyzing their effectiveness, and ensuring ethical considerations in implementation and evaluation.

CO6:-Collaborating effectively in architectural design strongly relates to research, analytical reasoning, and ethical conduct as it involves conducting research collaboratively, analyzing design options, and ensuring ethical conduct throughout the collaboration process.

CO7:-Exploring emerging trends in software architecture strongly relates to research, analytical reasoning, and ethical conduct as it involves researching new trends, analyzing their potential impact, and considering ethical implications in adopting emerging technologies.

Justification of PO6 to ALL COs:

CO1:-Understanding software architecture fundamentals strongly relates to communication, collaboration, and leadership as it provides a common language and foundation for effective communication and collaboration among team members and leadership in architectural decisions.

CO2:-Applying design patterns effectively strongly relates to communication, collaboration, and leadership as it requires clear communication of design intentions, collaboration among team members for pattern implementation, and leadership in guiding pattern selection and usage.

CO3:-Analyzing and critiquing existing architectures strongly relates to communication, collaboration, and leadership as it involves effectively communicating critiques,

collaborating with others to identify improvement opportunities, and demonstrating leadership in proposing architectural changes.

CO4:-Designing and documenting software architectures strongly relates to communication, collaboration, and leadership as it requires effective communication of design decisions, collaboration among stakeholders for input and feedback, and leadership in guiding the architectural design process.

CO5:-Implementing and evaluating architectural patterns strongly relates to communication, collaboration, and leadership as it involves coordinating with team members for pattern implementation, collaborating in evaluating pattern effectiveness, and demonstrating leadership in driving architectural improvements.

CO6:-Collaborating effectively in architectural design strongly relates to communication, collaboration, and leadership as it involves clear communication among team members, collaboration in architectural decision-making, and leadership in fostering a collaborative environment.

CO7:-Exploring emerging trends in software architecture moderately relates to communication, collaboration, and leadership as it involves sharing insights with team members, collaborating on the evaluation of trends, and demonstrating leadership in adopting relevant trends.

Justification of PO7 to ALL COs:

CO1:- Understanding software architecture fundamentals strongly relates to digital proficiency and technological skills as it forms the basis for acquiring and applying technical knowledge in software development.

CO2:- Applying design patterns effectively strongly relates to digital proficiency and technological skills as it requires a deep understanding of programming languages, frameworks, and tools to implement patterns correctly.

CO3:- Analyzing and critiquing existing architectures strongly relates to digital proficiency and technological skills as it involves assessing the technical aspects of architectures and understanding their implications on system performance and scalability.

CO4:- Designing and documenting software architectures strongly relates to digital proficiency and technological skills as it requires proficiency in architectural modeling tools, documentation tools, and understanding of technical standards.

CO5:- Implementing and evaluating architectural patterns strongly relates to digital proficiency and technological skills as it involves implementing patterns using programming languages, evaluating their performance, and leveraging technological tools for assessment.

CO6:- Collaborating effectively in architectural design strongly relates to digital proficiency and technological skills as it involves using collaboration tools, version control systems, and communication platforms that require digital proficiency.

CO7:- Exploring emerging trends in software architecture strongly relates to digital proficiency and technological skills as it involves researching and understanding new technologies, frameworks, and methodologies shaping the future of software architecture.

Justification of PO8 to ALL COs:

CO1:- Understanding software architecture fundamentals moderately relates to multicultural competence, inclusive spirit, and empathy as it lays the groundwork for understanding diverse perspectives and the importance of inclusivity in software development teams.

CO2:- Applying design patterns effectively moderately relates to multicultural competence, inclusive spirit, and empathy as it involves considering diverse viewpoints and ensuring that design decisions are inclusive and empathetic towards users from different backgrounds.

CO3:- Analyzing and critiquing existing architectures moderately relates to multicultural competence, inclusive spirit, and empathy as it requires understanding and respecting diverse architectural approaches and considering the impact of architectural decisions on different stakeholders.

CO4:- Designing and documenting software architectures moderately relates to multicultural competence, inclusive spirit, and empathy as it involves considering the needs and perspectives of diverse stakeholders and ensuring that architectural documentation is accessible and inclusive.

CO5:- Implementing and evaluating architectural patterns moderately relates to multicultural competence, inclusive spirit, and empathy as it involves considering diverse user needs and ensuring that architectural patterns are implemented in a way that is inclusive and empathetic.

CO6:- Collaborating effectively in architectural design strongly relates to multicultural competence, inclusive spirit, and empathy as it involves working with diverse teams and fostering an inclusive environment where all team members' perspectives are valued and respected.

CO7:- Exploring emerging trends in software architecture moderately relates to multicultural competence, inclusive spirit, and empathy as it involves considering how new technologies and trends can be applied in ways that are inclusive and empathetic towards diverse user populations.

Justification of PO9 to ALL COs:

CO1:- Understanding software architecture fundamentals moderately relates to value inculcation, environmental awareness, and ethical practices as it lays the foundation for making ethical decisions and considering the environmental impact of software systems.

CO2:- Applying design patterns effectively moderately relates to value inculcation, environmental awareness, and ethical practices as it involves considering ethical implications and environmental factors when selecting and applying design patterns.

CO3:- Analyzing and critiquing existing architectures moderately relates to value inculcation, environmental awareness, and ethical practices as it involves evaluating architectures based on ethical principles and environmental sustainability criteria.

CO4:- Designing and documenting software architectures moderately relates to value inculcation, environmental awareness, and ethical practices as it involves incorporating ethical considerations and environmental concerns into the design and documentation process.

CO5:- Implementing and evaluating architectural patterns moderately relates to value inculcation, environmental awareness, and ethical practices as it involves assessing the ethical implications and environmental impact of implementing architectural patterns.

CO6:- Collaborating effectively in architectural design strongly relates to value inculcation, environmental awareness, and ethical practices as it involves fostering a culture of ethical decision-making and considering environmental concerns in collaborative design efforts.

CO7:- Exploring emerging trends in software architecture moderately relates to value inculcation, environmental awareness, and ethical practices as it involves considering how new architectural trends align with ethical principles and environmental sustainability goals.

Justification of PO10 to ALL COs:

CO1:- Understanding software architecture fundamentals moderately relates to autonomy, responsibility, and accountability as it provides the knowledge necessary for individuals to autonomously make responsible decisions and be held accountable for them.

CO2:- Applying design patterns effectively moderately relates to autonomy, responsibility, and accountability as it involves individuals taking responsibility for selecting and applying patterns autonomously while being held accountable for their effectiveness.

CO3:- Analyzing and critiquing existing architectures moderately relates to autonomy, responsibility, and accountability as it involves individuals autonomously assessing architectures, taking responsibility for critiques, and being held accountable for their evaluations.

CO4:- Designing and documenting software architectures strongly relates to autonomy, responsibility, and accountability as it involves individuals autonomously making design decisions, taking responsibility for their designs, and being held accountable for the quality of documentation.

CO5:- Implementing and evaluating architectural patterns moderately relates to autonomy, responsibility, and accountability as it involves individuals autonomously implementing patterns, evaluating their effectiveness, and being held accountable for their implementation decisions.

CO6:- Collaborating effectively in architectural design strongly relates to autonomy, responsibility, and accountability as it involves individuals autonomously contributing to collaborative efforts, taking responsibility for their contributions, and being held accountable for their role in the collaboration.

CO7:- Exploring emerging trends in software architecture moderately relates to autonomy, responsibility, and accountability as it involves individuals autonomously researching trends, taking responsibility for identifying relevant trends, and being held accountable for their assessments of their potential impact.

SYLLABUS (CBCS as per NEP 2020) FOR M. Sc. (Computer Science)
(w. e. from June,2024)

Name of the Programme	: M.Sc. Computer Science
Programme Code	: PSCOS
Class	: M.Sc. (Computer Science) II
Semester	: III
Course Type	: Major (Mandatory) (TH)
Course Name	: Machine Learning
Course Code	: COS-602-MJM
No. of Lectures	: 60 Hours
No. of Credits	: 04

Course Objectives:

1. Acquire theoretical Knowledge on setting hypothesis for pattern recognition.

2. Apply suitable machine learning techniques for data handling and to gain knowledge from it.

3. Evaluate the performance of algorithms and to provide solution for various real world applications

Course Outcomes:

CO1: Recognize the characteristics of Machine Learning techniques that enable to solve real world problem.

CO2. Recognize the characteristics of machine learning strategies.

CO3. Apply various supervised learning methods to appropriate problems.

CO4. Identify and integrate more than one technique to enhance the performance of learning.

CO5. Create probabilistic and unsupervised learning models for handling unknown pattern.

CO6. Analyze the co-occurrence of data to find interesting frequent patterns.

CO7. Design and apply various reinforcement algorithms to solve real time complex problems.

Units	Title and Contents	No. of Lectures
Unit I	• **Introduction to Machine Learning** Introduction , Components of Learning , Learning Models , Geometric Models, Probabilistic Models, Logic Models, Grouping and Grading, Designing a Learning System, Types of Learning, Supervised, Unsupervised, Reinforcement, Version Spaces, PAC Learning, VC Dimension.	10
Unit II	• **Supervised and Unsupervised Learning** Decision Trees, Classification and Regression Trees, Regression: Linear Regression, Multiple Linear Regression, Logistic Regression, Neural Networks: Introduction, Perception, Multilayer Perception, Introduction to clustering, K-means clustering, K-Mode Clustering.	16
Unit III	• **Probabilistic Learning** Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting, Stacking. Gaussian mixture models - The Expectation-Maximization (EM) Algorithm, Information Criteria, Nearest neighbour methods - Nearest Neighbour Smoothing.	12
Unit IV	• **Reinforcement Learning and Evaluating Hypotheses** Introduction, Learning Task, Q Learning, Non deterministic Rewards and actions, temporal-difference learning, Relationship to Dynamic Programming, Active reinforcement learning, Generalization in reinforcement learning. Motivation, Basics of Sampling Theory: Error Estimation and Estimating Binomial Proportions, The Binomial Distribution, Estimators, Bias, and Variance	14
Unit V	• **Genetic Algorithms** Motivation, Genetic Algorithms: Representing Hypotheses, Genetic Operator, An Illustrative Example, Hypothesis Space Search, Genetic Programming, Models of Evolution and Learning, Baldwin Effect, Parallelizing Genetic Algorithms.	08

CBCS Syllabus 2023 Pattern M.Sc.(CS)- II Sem-III as per NEP 2020

References Book:

1. haruC.Aggarwal,"DataClassificationAlgorithmsandApplications",CRCPress,2014.

2. Charu C. Aggarwal, "DATA CLUSTERING Algorithms and Applications", CRC Press, 2014.

3. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012

4. Jiawei Han and Micheline Kambers and JianPei, "Data Mining Concepts andTechniques",3rd edition, Morgan Kaufman Publications, 2012

Mapping of this course with Programme Outcomes

Course Outcomes	Programme Outcomes (POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	3	3	2	2	2
CO2	3	3	3	3	3	3	3	2	-	2
CO3	3	3	3	3	3	3	3	2	2	3
CO4	3	3	3	3	3	3	3	2	2	3
CO5	3	3	3	3	3	3	3	2	2	3
CO6	-	3	-	3	3	3	3	2	2	3
CO7	3	3	3	3	3	3	3	2	2	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

Justification of PO1 to ALL COs:
Understanding machine learning strategies is fundamental to addressing real-world problems effectively, as it allows for the selection and application of appropriate techniques. Hence, it is strongly related to PO1. (Weightage: 3)

Justification of PO2 to ALL COs:
Designing and applying reinforcement algorithms requires practical and procedural knowledge, essential for professionals solving real-time complex problems. Therefore, it strongly relates to PO2. (Weightage: 3)

Justification of PO3 to ALL COs:
Creating probabilistic and unsupervised models reflects an entrepreneurial mindset by addressing uncertainties in data and innovatively handling unknown patterns, thus strongly related to PO3. (Weightage: 3)

Justification of PO4 to ALL COs:

Creating probabilistic and unsupervised models involves specialized skills and critical thinking to tackle unknown patterns effectively, thus strongly related to PO4. (Weightage: 3)

Justification of PO5 to ALL COs:

Analysing data co-occurrence requires analytical reasoning and research skills to identify patterns and derive insights ethically, strongly related to PO5. (Weightage: 3)

Justification of PO6 to ALL COs:

Identifying and integrating multiple techniques often involves collaboration with experts in different ML domains. Effective communication and collaboration are essential for integrating these techniques to solve real-world problems, strongly related to PO6. (Weightage: 3)

Justification of PO7 to ALL COs:

Applying supervised learning methods requires proficiency in using ML tools and technologies to implement these methods effectively. Hence, it is strongly related to PO7. (Weightage: 3)

Justification of PO8 to ALL COs:

Integrating multiple techniques may involve considering diverse perspectives and approaches, contributing to a more inclusive problem-solving process, hence it's moderately related. (Weightage: 2)

Justification of PO9 to ALL COs:

Understanding ML techniques can contribute to ethical practices by ensuring the responsible use of technology to address real-world problems. Hence, it's moderately related to PO9.(Weightage: 2)

Justification of PO10 to ALL COs:

Identifying and integrating multiple techniques demonstrates autonomy in decision-making and accountability for the performance of the learning process.

SYLLABUS (CBCS as per NEP 2020) FOR M. Sc. (Computer Science)

(w. e. from June, 2024)

Name of the Programme	: M.Sc. (Computer Science)
Program Code	: PSCOS
Class	: M.Sc. (Computer Science)-II
Semester	: III
Course Type	: Major(Practical)
Course Name	: Web API Using .Net Framework.
Course Code	: COS-603-MJM
No. of Practical's	: 10 Practical's + Learning (60 Hours)
No. of Credits	: 02

Course Objectives :

1. To Understand the purpose and role of Web APIs in modern web development.
2. Explore the basics of the ASP.NET framework and its components.
3. Implement content negotiation to support various data formats, such as JSON and XML.
4. To Understand paradigms needed for testing web applications.
5. Understand and apply best practices for designing RESTful APIs.

Course Outcome :

CO1: Understand the principles of Web API.
CO2: Understand the MVC (Model-View-Controller) pattern.
CO3: Ability to write the Web application using ASP.Net Core MVC -API.
CO4: Learn the basics of ASP.NET Web API architecture and its components.
CO5: Implement routing in Web API to handle different HTTP requests.
CO6: Implement authentication mechanisms for Web API endpoints.
CO7: Deploy a Web API to a hosting environment.

Topic No.	Topic Name	No. of Assignments
1	**Controllers and Actions** • Convention-based routing • Parameter binding conventions • Parameter binding attributes • HTTP verb attributes • Return values • Validating models	1
2	**Routing** • Routing table • Attribute routing • Customizing attribute routes	2

3	**Data Serialization and Model Binding** • Models and DTOs • CRUD operations with Entity Framework • Useful Json.NET settings • Reference Loop Handling in action	2
4	**Error Handling** • Using HttpResponseException • Using exception filters • Using exception loggers • Global exception handler	2
5	**API Documentation and Testing** • Documenting with help pages • Documenting with Swashbuckle and Swagger • API testing client Postman	1
6	**Security** • Authorize attribute • Allow Anonymous attribute • Setting user principal • Overview of JSON web tokens • JWT in action	2

Note: There are 40Hrs for assignment completion and 20Hrs for learning

Reference Books:

1.Practical ASP .NET Web API , Badrinaranan Lakshmiraghavan

2. ASP .NET Web API Core, John kocer

3. Programming ASP.NET Core , Dino Esposito , PHI LEARNING PVT. LTD. MICROSOFT

4. ASP.NET Core for Jobseekers , Kemal Birer , bpb publication

5. Learning ASP.NET Core MVC Programming , (English, Paperback, Ragupathi Mugilan T. S.)

Online Links :

ASP.Net MVC-Web API Tutorial for Beginner's: https://www.w3schools.com/mvc/
https://www.geeksforgeeks.org/dotnetcore/
https://www.tutorialspoint.com/

Mapping of this course with Programme Outcomes

Course Outcomes	Programme Outcomes (POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	2	2	3	2	2	2
CO2	3	3	2	3	2	2	3	2	2	2
CO3	3	3	2	3	2	2	3	2	2	2
CO4	3	3	2	3	2	2	3	2	2	2
CO5	3	3	2	3	2	2	3	2	2	2
CO6	3	3	2	3	2	2	3	2	2	2
CO7	3	3	2	3	2	2	3	2	2	2

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

Justification:

1.Mapping PO1 to All CO's :

CO1, CO2, CO3, CO4, CO5, CO6, and CO7 are strongly related to PO1 as PO1 emphasizes the profound understanding of foundational theories and methodologies, which are closely linked to understanding principles (CO1), MVC pattern (CO2), and the ability to write and deploy Web applications using ASP.Net Core MVC (CO3 and CO7). While CO4, CO5, and CO6 contribute to the understanding and application of specific technologies and concepts within the broader context of web API development.

2.Mapping PO2 to All CO's :

CO1, CO2, CO3, CO4, CO5, CO6, and CO7 are strongly related to PO2 as PO2 emphasizes the acquisition of practical skills and expertise necessary for professional tasks, which are directly applicable in real-world scenarios. Understanding the principles (CO1) and patterns (CO2) of Web API development, along with the ability to write, deploy, and secure Web applications (CO3, CO5, CO6, CO7), align closely with the practical skills and expertise required in professional settings. Additionally, learning the basics of ASP.NET Web API architecture (CO4) contributes to understanding industry standards and best practices in web development.

3.Mapping PO3 to All CO's :

CO1, CO2, CO3, CO4, CO5, CO6, and CO7 are moderately related to PO3. While understanding the principles (CO1) and patterns (CO2) of Web API development, along with the ability to write, deploy, and secure Web applications (CO3, CO6, CO7), can be beneficial in entrepreneurial endeavors, they are not directly tied to cultivating an entrepreneurial mindset, identifying opportunities, fostering innovation, or understanding business principles and market dynamics.

4.Mapping PO4 to All CO's :

CO1, CO2, CO3, CO4, CO5, CO6, and CO7 are strongly related to PO4. Understanding the principles (CO1) and patterns (CO2) of Web API development provides a foundation for technical skills and analytical abilities. Writing, deploying, and securing Web applications (CO3, CO6, CO7) also contribute to technical proficiency. Effective communication and leadership may not be directly addressed by these specific technical skills but could be demonstrated in the context of project management, collaboration, and presenting technical solutions, which are indirectly supported by the course outcomes.

5.Mapping PO5 to All CO's :

CO1, CO2, CO3, CO4, CO5, CO6, and CO7 are moderately related to PO5. While the topics covered in the course provide technical skills related to web API development, they are not directly aligned with observational and inquiry skills, research methodologies, data analysis, or research ethics. However, proficiency in technical skills and understanding of software architecture gained from the course might indirectly support research-related activities.

6.Mapping PO6 to All CO's :

CO1, CO2, CO3, CO4, CO5, CO6, and CO7 are moderately related to PO6. While the course focuses on technical aspects of web API development, it indirectly supports communication, collaboration, and leadership qualities by providing opportunities for teamwork, project management, and presenting technical solutions. However, the direct emphasis of the course is on technical skills rather than soft skills related to communication and leadership. Therefore, there is a moderate relationship between the program outcome and the course outcomes.

7.Mapping PO7 to All CO's :

CO1, CO2, CO3, CO4, CO5, CO6, and CO7 are strongly related to PO7.The course covers various aspects of web API development, including principles, architecture, routing, authentication, and deployment. These skills directly contribute to proficiency in using ICT and adapting to technological advancements, as well as accessing information sources and analyzing data using appropriate software within the context of web development. Therefore, there is a strong relationship between the program outcome and the course outcomes.

8.Mapping PO8 to All CO's :

CO1, CO2, CO3, CO4, CO5, CO6, and CO7 are Moderately related to PO8.While the course focuses on technical aspects of web API development, it does not directly address engagement in multicultural settings, leading diverse teams, or demonstrating empathy and understanding of others' perspectives and emotions. These aspects are more related to soft skills and interpersonal abilities rather than technical skills covered in the course.

9.Mapping PO8 to All CO's :

CO1, CO2, CO3, CO4, CO5, CO6, and CO7 are Moderately related to PO9. While the course provides technical skills related to web API development, it does not directly address ethical and moral values, responsible citizenship, or environmental conservation. These aspects are more related to personal values, societal awareness, and ethical decision-making, rather than technical skills covered in the course.

10.Mapping PO8 to All CO's :

This alignment suggests that the Program Outcome PO10 is moderately related to all of the Course Outcomes (CO). The course provides technical knowledge and skills related to web API development, which can contribute to the ability to work independently, manage projects effectively, and demonstrate responsibility and accountability in work contexts. However, these outcomes also require additional factors such as project management skills, time management, and professional ethics, which are not directly addressed in the technical aspects covered by the course.

CBCS Syllabus 2023 Pattern M.Sc.(CS)- II Sem-III as per NEP 2020

SYLLABUS (CBCS as per NEP 2020) FOR M. Sc. (Computer Science)-II Sem-III

(w. e. f. A.Y 2024-25)

Name of the Program	: M.Sc. Computer Science
Program Code	: PSCOS
Class	: M.Sc. (Computer Science)
Semester	: III
Course Type	: Major (PR)
Course Name	: Advance Python Programming
Course Code	: COS-604-MJM
No. of Lectures	: 60
No. of Credits	: 02

A) Course Objectives:

1 - To understand and gain knowledge of all types of programming.

2 - To understand and solve the functional and procedural problems.

3 - work with GUI in Python

4 - understand and use Modules.

5 - use basic of NumPy.

6 - use basic of Pandas.

7 - To understand the Database Programming

B) Course Outcomes:

CO 1 - To understand why Python is a useful for UI developers.

CO 2 - To learn how to use Tkinter in Python programs.

CO 3 - To learn how to use SQL database in Python programs.

CO 4 - To learn how to use MongoDB in Python.

CO 5 - To learn how to use Network programming.

CO 6 - To learn the use of NumPy in Python.

CO 7 - To learn the use of Pandas in Python

Units	Contents and Assignment
Unit 1	**Writing GUIs in Python (Tkinter)** • Introduction • Components and Events • An Example GUI • The root Component • Adding a Button • Entry Widgets • Text Widgets • Check buttons **No. of Assignments – 4**

Unit 2	**Python SQL Database Access** • Introduction • Installation • DB Connection • Creating DB Table • INSERT, READ, UPDATE, DELETE operations. • COMMIT & ROLLBACK operation. • Handling Errors **No. of Assignments – 4**
Unit 3	**Network Programming** • Introduction • A Daytime Server • Clients and Servers • The Client Program • The Server Program **No. of Assignments - 4**
Unit 4	**Python MongoDB** • Introduction • Installation • DB Connection • Creating DB Table • INSERT, READ, UPDATE, DELETE operations. **No. of Assignments - 4**
Unit 5	**Python Libraries** **NumPy** • Array in NumPy • Data Types in NumPy • Methods in NumPy • String Operations • Sorting, Searching and Counting **Pandas** • Data Frame • Working with Text Data • Pandas Merging, Joining, and Concatenating **No. of Assignments - 4**

Reference Books:

1. Python GUI Programming with Tkinter – By Alan D Moore
2. Databases and Python Programming: MySQL, MongoDB, OOP and Tkinter- By R PANNEERSELVAM
3. Foundations of Python Network Programming: The comprehensive guide to building network applications with Python – By Brandon Rhodes and John Goerzen

4. Guide to NumPy – Travis E. OLIPHANT PHD

Online Links:
1. Python Tutorial for Beginner's:
   https://www.w3schools.com/python/

   https://www.geeksforgeeks.org/python-programming-language/

   https://www.tutorialspoint.com/python/index.htm

Course Outcomes	Programme Outcomes (POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	2	2	1	1	2
CO2	3	3	2	3	3	3	3	1	1	2
CO3	3	3	3	3	3	3	2	1	2	3
CO4	3	3	2	2	2	2	2	1	1	2
CO5	3	3	3	3	3	3	3	1	1	3
CO6	3	3	3	3	3	3	2	1	2	3
CO7	3	3	3	3	3	3	2	1	2	3

Weight: 1 - Partially related   2 - Moderately Related   3 - Strongly related

Course Objectives (CO) and Program Outcomes (PO) Mapping:
- **Justification of PO1 to ALL COs :**

CO1 (3): Understanding foundational concepts and principles in electronic banking.
CO2 (3): Proficiency in utilizing various technologies and platforms in electronic banking.
CO3 (3): Recognizing the importance of security in electronic banking.
CO4 (3): Understanding the various services offered in electronic banking.
CO5 (3): Ability to perform common transactions in electronic banking.
CO6 (3): Understanding security threats and cybercrimes in electronic banking.
CO7 (3): Ability to identify and prevent security threats and cybercrimes in electronic banking.

2. **Justification of PO2 to ALL COs :**

CO1 (3): Understanding foundational concepts and principles in electronic banking, which is crucial for practical application and professional knowledge.
CO2 (3): Proficiency in utilizing various technologies and platforms in electronic banking, directly impacting professional knowledge and procedural skills.
CO3 (3): Recognizing the importance of security in electronic banking, essential for professional conduct and procedural adherence.
CO4 (3): Understanding the various services offered in electronic banking, relevant for practical application and professional knowledge.
CO5 (3): Ability to perform common transactions in electronic banking, crucial for procedural skills and practical application.
CO6 (3): Understanding security threats and cybercrimes in electronic banking, important for professional knowledge and procedural skills.
CO7 (3): Ability to identify and prevent security threats and cybercrimes in electronic banking, directly impacting professional conduct and procedural adherence.

3. Justification of PO3 to ALL COs :

CO1 (2): Understanding foundational concepts and principles in electronic banking contributes to business understanding and innovation by providing a basis for new ideas and solutions.

CO2 (2): Proficiency in utilizing various technologies and platforms in electronic banking is moderately related to entrepreneurial mindset and innovation, as it involves understanding and adapting to new technologies.

CO3 (3): Recognizing the importance of security in electronic banking is strongly related to entrepreneurial mindset, as it emphasizes risk management and innovation in security measures.

CO4 (2): Understanding the various services offered in electronic banking is moderately related to business understanding, as it involves knowledge of market offerings and customer needs.

CO5 (3): Ability to perform common transactions in electronic banking is strongly related to entrepreneurial mindset, as it enables efficient business operations and customer service.

CO6 (3): Understanding security threats and cybercrimes in electronic banking is strongly related to entrepreneurial mindset and innovation, as it involves identifying and mitigating risks to business operations.

CO7 (3): Ability to identify and prevent security threats and cybercrimes in electronic banking is strongly related to entrepreneurial mindset, as it involves proactive risk management and innovation in security practices.

4. Justification of PO4 to ALL COs :

CO1 (2): Understanding foundational concepts and principles in electronic banking is moderately related to specialized skills, critical thinking, and problem-solving, as it involves acquiring and applying knowledge.

CO2 (3): Proficiency in utilizing various technologies and platforms in electronic banking is strongly related to specialized skills, critical thinking, and problem-solving, as it requires understanding complex systems and adapting to new technologies.

CO3 (3): Recognizing the importance of security in electronic banking is strongly related to specialized skills, critical thinking, and problem-solving, as it involves analyzing risks and implementing solutions.

CO4 (2): Understanding the various services offered in electronic banking is moderately related to specialized skills, critical thinking, and problem-solving, as it involves understanding and addressing customer needs.

CO5 (3): Ability to perform common transactions in electronic banking is strongly related to specialized skills, critical thinking, and problem-solving, as it requires applying knowledge to complete tasks efficiently.

CO6 (3): Understanding security threats and cybercrimes in electronic banking is strongly related to specialized skills, critical thinking, and problem-solving, as it involves analyzing complex threats and developing strategies to mitigate them.

CO7 (3): Ability to identify and prevent security threats and cybercrimes in electronic banking is strongly related to specialized skills, critical thinking, and problem-solving, as it requires analyzing threats and implementing effective countermeasures.

5. Justification of PO5 to ALL COs :

CO1 (2): Understanding foundational concepts and principles in electronic banking is moderately related to research, analytical reasoning, and ethical conduct, as it involves acquiring and applying knowledge.

CO2 (3): Proficiency in utilizing various technologies and platforms in electronic banking is strongly related to research, analytical reasoning, and ethical conduct, as it requires analyzing complex systems and adhering to ethical standards.

CO3 (3): Recognizing the importance of security in electronic banking is strongly related to research, analytical reasoning, and ethical conduct, as it involves analyzing security risks and ethical considerations.

CO4 (2): Understanding the various services offered in electronic banking is moderately related to research, analytical reasoning, and ethical conduct, as it involves analyzing market trends and ethical implications.

CO5 (3): Ability to perform common transactions in electronic banking is strongly related to research, analytical reasoning, and ethical conduct, as it requires applying knowledge to complete tasks ethically and efficiently.

CO6 (3): Understanding security threats and cybercrimes in electronic banking is strongly related to research, analytical reasoning, and ethical conduct, as it involves analyzing threats and ethical considerations in security measures.

CO7 (3): Ability to identify and prevent security threats and cybercrimes in electronic banking is strongly related to research, analytical reasoning, and ethical conduct, as it requires analyzing threats and implementing ethical security practices.

6. Justification of PO6 to ALL COs :

CO1 (2): Understanding foundational concepts and principles in electronic banking is moderately related to research, analytical reasoning, and ethical conduct, as it involves acquiring and applying knowledge.

CO2 (3): Proficiency in utilizing various technologies and platforms in electronic banking is strongly related to research, analytical reasoning, and ethical conduct, as it requires analyzing complex systems and adhering to ethical standards.

CO3 (3): Recognizing the importance of security in electronic banking is strongly related to research, analytical reasoning, and ethical conduct, as it involves analyzing security risks and ethical considerations.

CO4 (2): Understanding the various services offered in electronic banking is moderately related to research, analytical reasoning, and ethical conduct, as it involves analyzing market trends and ethical implications.

CO5 (3): Ability to perform common transactions in electronic banking is strongly related to research, analytical reasoning, and ethical conduct, as it requires applying knowledge to complete tasks ethically and efficiently.

CO6 (3): Understanding security threats and cybercrimes in electronic banking is strongly related to research, analytical reasoning, and ethical conduct, as it involves analyzing threats and ethical considerations in security measures.

CO7 (3): Ability to identify and prevent security threats and cybercrimes in electronic banking is strongly related to research, analytical reasoning, and ethical conduct, as it requires analyzing threats and implementing ethical security practices.

7. Justification of PO7 to ALL COs :

CO1 (2): Understanding foundational concepts and principles in electronic banking is moderately related to digital proficiency and technological skills, as it involves acquiring knowledge about digital technologies.

CO2 (3): Proficiency in utilizing various technologies and platforms in electronic banking is strongly related to digital proficiency and technological skills, as it requires hands-on experience with digital tools.

CO3 (2): Recognizing the importance of security in electronic banking is moderately related to digital proficiency and technological skills, as it involves understanding security technologies and measures.

CO4 (2): Understanding the various services offered in electronic banking is moderately related to digital proficiency and technological skills, as it involves understanding digital services and platforms.

CO5 (3): Ability to perform common transactions in electronic banking is strongly related to digital proficiency and technological skills, as it requires practical skills in using digital tools for transactions.

CO6 (2): Understanding security threats and cybercrimes in electronic banking is moderately related to digital proficiency and technological skills, as it involves understanding digital threats and vulnerabilities.

CO7 (2): Ability to identify and prevent security threats and cybercrimes in electronic banking is moderately related to digital proficiency and technological skills, as it involves applying digital security measures.

8. Justification of PO8 to ALL COs :

CO1 (1): Understanding foundational concepts and principles in electronic banking is partially related to multicultural competence, inclusive spirit, and empathy, as it provides knowledge that can be applied in diverse cultural contexts.

CO2 (1): Proficiency in utilizing various technologies and platforms in electronic banking is partially related to multicultural competence, inclusive spirit, and empathy, as it involves interacting with diverse users and understanding their needs.

CO3 (1): Recognizing the importance of security in electronic banking is partially related to multicultural competence, inclusive spirit, and empathy, as it involves understanding security concerns of diverse user groups.

CO4 (1): Understanding the various services offered in electronic banking is partially related to multicultural competence, inclusive spirit, and empathy, as it involves considering the needs of diverse users.

CO5 (1): Ability to perform common transactions in electronic banking is partially related to multicultural competence, inclusive spirit, and empathy, as it involves providing services that meet the needs of diverse users.

CO6 (1): Understanding security threats and cybercrimes in electronic banking is partially related to multicultural competence, inclusive spirit, and empathy, as it involves understanding how different user groups may be targeted.

CO7 (1): Ability to identify and prevent security threats and cybercrimes in electronic banking is partially related to multicultural competence, inclusive spirit, and empathy, as it involves protecting diverse users from harm.

9. Justification of PO9 to ALL COs :

CO1 (1): Understanding foundational concepts and principles in electronic banking is partially related to value inculcation, environmental awareness, and ethical practices, as it provides a basis for ethical decision-making.

CO2 (1): Proficiency in utilizing various technologies and platforms in electronic banking is partially related to value inculcation, environmental awareness, and ethical practices, as it involves understanding and adhering to ethical standards in technology use.

CO3 (2): Recognizing the importance of security in electronic banking is moderately related to value inculcation, environmental awareness, and ethical practices, as it involves understanding the ethical implications of security measures.

CO4 (1): Understanding the various services offered in electronic banking is partially related to value inculcation, environmental awareness, and ethical practices, as it involves considering the ethical aspects of service provision.

CO5 (1): Ability to perform common transactions in electronic banking is partially related to value inculcation, environmental awareness, and ethical practices, as it involves conducting transactions ethically.

CO6 (2): Understanding security threats and cybercrimes in electronic banking is moderately related to value inculcation, environmental awareness, and ethical practices, as it involves understanding the ethical implications of cybercrimes.

CO7 (2): Ability to identify and prevent security threats and cybercrimes in electronic banking is moderately related to value inculcation, environmental awareness, and ethical practices, as it involves implementing ethical security practices.

10. Justification of PO10 to ALL COs :

CO1 (2): Understanding foundational concepts and principles in electronic banking is moderately related to autonomy, responsibility, and accountability, as it provides the knowledge needed to make autonomous and responsible decisions.

CO2 (2): Proficiency in utilizing various technologies and platforms in electronic banking is moderately related to autonomy, responsibility, and accountability, as it involves taking responsibility for using technology effectively and ethically.

CO3 (3): Recognizing the importance of security in electronic banking is strongly related to autonomy, responsibility, and accountability, as it involves taking responsibility for ensuring security measures are in place.

CO4 (2): Understanding the various services offered in electronic banking is moderately related to autonomy, responsibility, and accountability, as it involves understanding the responsibilities associated with each service.

CO5 (3): Ability to perform common transactions in electronic banking is strongly related to autonomy, responsibility, and accountability, as it involves taking responsibility for managing one's own finances.

CO6 (3): Understanding security threats and cybercrimes in electronic banking is strongly related to autonomy, responsibility, and accountability, as it involves understanding the need to protect oneself from these threats.

CO7 (3): Ability to identify and prevent security threats and cybercrimes in electronic banking is strongly related to autonomy, responsibility, and accountability, as it involves taking proactive steps to protect oneself and others.

SYLLABUS (CBCS as per NEP 2020) FOR M. Sc. (Computer Science)
(w. e. f. A.Y 2024-25)

Name of the Programme : M.Sc. Computer Science
Program Code : PSCOS
Class : M.Sc. (Computer Science)
Semester : III
Course Type : Major (Theory)
Course Name : Data Science & Analytics.
Course Code : COS-611-MJE (A)
No. of Lectures : 30
No. of Credits : 02

A. Course Objectives:
1. Understand the concepts of Data Procedures.
2. Learn the tools to analyze the data.
3. Develop python application with visualization effects.
4. Understand programming skills in Python.

B. Course outcomes:
Students successfully completing this course will be able to:

CO1- Analyse the nature of data with the help of statistical methods and different visualization techniques.

CO2- Evaluate the model performance by applying various algorithms and communicate the observations.

CO3- Apply and analyse data analytical methods for real life problems.

CO4- Students will develop relevant programming abilities.

CO5- Students will demonstrate proficiency with statistical analysis of data.

CO6- Students will develop the ability to build and assess data-based models.

CO7- Students will execute statistical analyses with professional statistical software.

Unit	Title and Contents	No. of Lectures
Unit 1	**Introduction to Data Science** **1.1** Introduction to Data **1.2** Data Vs Information **1.3** Types of Data **1.4** Big Data and Data Science **1.5** Structured Data, Unstructured Data **1.6** Business Intelligence Data Science	05

Unit 2	**Statistics for Data Science** 2.1. Population and Samples 2.2. The Fundamentals of Descriptive Statistics: Frequency Distribution, Measures of Central Tendency and Dispersion: Range, Standard Deviation, Variance 2.3. Correlation and Regression 2.4. Multiple Linear Regression	9
Unit 3	**Data Visualization and Data Analytics Using Python Tools** 3.1. Basic of Data Visualization: Line plot, Scatter plot, Boxplot, Histogram, Bar chart, Pie chats etc. 3.2. Need of data modelling 3.3. Multidimensional data models 3.4. Principal component analysis 3.5. Clustering of high dimensional data 3.6. Data Analytics Using Python Library- NumPy and pandas. 3.7. Data Analytics Using Python Library- Seaborn and Matplotlib.	10
Unit 4	**Predictive Data Analytics** 4.1. Introduction to Data Analytics 4.2. Types of Data Analytics 4.3. Data Analytics Process Steps 4.4. Association Rule 4.5. Classification: Decision Trees	06

NOTE: Internal Evaluation of this Subject includes Case Studies & Real Life examples.

References:

1. Data Science and Big Data Analytics Publisher, Wiley, ISBN:9781118876053, 1118876059

2. Data Analytics Publisher, McGraw Hill Education (India) Private Limited, ISBN:9789352604180, 9352604180

3. Data Analytics for Beginners Publisher, CreateSpace Independent Publishing Platform, ISBN:9781539896739, 1539896730

4. Data Science and Big Data Analytics, Gitatech Publishing House, ISBN: 9788195243907

Mapping of this course with Programme Outcomes

Course Outcomes	Programme Outcomes (POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	P08	PO9	PO10
CO1	3	3	3	3	3	3	3	2	2	3
CO2	2	3	2	3	3	3	3	2	2	3
CO3	2	3	3	3	3	3	3	2	2	3
CO4	1	2	1	3	2	2	3	1	1	2
CO5	3	3	3	3	3	3	3	2	2	3
CO6	2	3	2	3	3	3	3	2	2	3
CO7	1	3	2	3	3	3	3	2	2	3

Weight: 1 - Partially related   2 - Moderately Related 3 - Strongly related

Course Objectives (CO) and Program Outcomes (PO) Mapping:

1. **Justification of PO1 to ALL COs:**
   CO1: Enriching knowledge in foundational theories and methodologies within a multidisciplinary context.
   CO2: Enriching knowledge in Artificial Intelligence, Design and Analysis of Algorithms, and other core computing subjects.
   CO3: Understanding foundational theories and methodologies within a multidisciplinary context.
   CO4: Enriching knowledge in Paradigm of Programming language and other core computing subjects.
   CO5: Enriching knowledge in foundational theories and methodologies within a multidisciplinary context.
   CO6: Enriching knowledge in areas like Artificial Intelligence and Database Technologies.
   CO7: Enriching knowledge in Database Technologies and other core computing subjects.

2. **Justification of PO2 to ALL COs:**
   CO1: Acquiring practical skills and expertise necessary for professional tasks.
   CO2: Essential skills for effective application in real-world scenarios.
   CO3: Practical skills and effective application in real-world scenarios.
   CO4: Acquiring practical skills and expertise necessary for professional tasks, as programming is often required in real-world scenarios.
   CO5: Acquiring practical skills and expertise necessary for professional tasks, especially in industries where data analysis is crucial.
   CO6: Essential for effective application in real-world scenarios.
   CO7: Acquiring practical skills and expertise necessary for professional tasks.

3. **Justification of PO3 to ALL COs:**
   CO1: Understanding market dynamics and identifying opportunities, fostering an entrepreneurial mindset.
   CO2: Understanding market dynamics and fostering innovation, essential for an entrepreneurial mindset.
   CO3: Identifying opportunities and fostering innovation, crucial in cultivating an entrepreneurial mindset.
   CO4: Understanding business principles and fostering innovation.
   CO5: Understanding market dynamics and identifying opportunities, essential in an entrepreneurial mindset.
   CO6: Fostering innovation and understanding market dynamics.
   CO7: Understanding market dynamics and risk management strategies, crucial for fostering an entrepreneurial mindset.

4. **Justification of PO4 to ALL COs:**
   CO1 : Develops critical thinking and problem-solving skills.
   CO2 : Analytical abilities and effective communication skills.
   CO3 : Technical skills and problem-solving abilities.
   CO4 : Correlates with proficiency in technical skills and problem-solving.
   CO5 : Data showcases technical skills and analytical abilities.
   CO6 : Requires critical thinking and problem-solving skills.
   CO7 : Demonstrates proficiency in technical skills and problem-solving.

5. **Justification of PO5 to ALL COs:**
   CO1 : Research and analytical reasoning skills.
   CO2 : Demonstrate analytical reasoning and effective reporting of findings.
   CO3 : Requires observational skills and adherence to research ethics.
   CO4 : Formulating research questions and utilizing appropriate methodologies for data analysis.
   CO5 : Utilizing appropriate methodologies for data analysis.
   CO6 : Research and analytical reasoning skills.
   CO7 : Utilizing appropriate methodologies for data analysis and adhering to research ethics.

6. **Justification of PO6 to ALL COs:**
   CO1 : Requires effective communication of complex information.
   CO2 : Necessitate effective communication skills.
   CO3 : Collaboration in diverse teams toward common goals.
   CO4 : Collaborating in diverse teams and facilitating cooperative efforts.
   CO5 – PO6: Requires effective communication of findings.
   CO6 : Collaboration in diverse teams and demonstrating leadership qualities.
   CO7 : Effective communication and collaborative efforts toward common goals.

7. **Justification of PO7 to ALL COs:**
   CO1 : Requires proficiency in using appropriate software and adapting to technological advancements.
   CO2 : Involve utilizing appropriate software for analysis, demonstrating digital proficiency and technological skills.
   CO3 : Necessitates proficiency in using ICT and adapting to technological advancements.
   CO4 : Developing programming abilities involves utilizing ICT and adapting to technological advancements.
   CO5 : Demonstrating proficiency with statistical analysis of data involves using appropriate software and adapting to technological advancements.

CO6 : Developing the ability to build and assess data-based models requires proficiency in using appropriate software and adapting to technological advancements.
CO7 : Aligns with demonstrating proficiency in using ICT and technological skills.

8. **Justification of PO8 to ALL COs:**
    CO1: Engaging with diverse datasets and understanding different perspectives.
    CO2: Require considering diverse perspectives and fostering inclusive communication.
    CO3: Involve understanding diverse contexts and perspectives.
    CO4: It may involve working in diverse teams but doesn't directly address multicultural competence or empathy.
    CO5: Require understanding diverse datasets and perspectives.
    CO6: Involve considering diverse perspectives and understanding different contexts.
    CO7: Require engaging effectively in multicultural settings and respecting diverse perspectives.

9. **Justification of PO9 to ALL COs:**
    CO1: Contribute to recognizing and addressing ethical issues related to data collection, analysis, and interpretation.
    CO2: Involve considering ethical implications and promoting ethical practices in data analysis and reporting.
    CO3: Require considering ethical considerations and promoting sustainability in problem-solving approaches.
    CO4: It may indirectly contribute to addressing ethical issues and promoting environmental awareness.
    CO5: Involve recognizing ethical considerations in data handling and promoting responsible data practices.
    CO6: Involve considering ethical implications of model outcomes and promoting ethical practices in model development.
    CO7: Involve promoting ethical data practices and recognizing environmental implications of data analysis.

10. **Justification of PO10 to ALL COs:**
    CO1: Demonstrates autonomy and responsibility in applying knowledge.
    CO2: Independently shows accountability in managing projects effectively.
    CO3: Independently contributes to societal well-being and demonstrates accountability.
    CO4: Managing projects effectively and demonstrating responsibility.
    CO5: Contributes to societal well-being and shows accountability.
    CO6: Independently showcases autonomy and responsibility in applying knowledge.
    CO7: Independently demonstrates autonomy and responsibility in applying skills.

SYLLABUS (CBCS as per NEP 2020) FOR M. Sc. (Computer Science)

(w. e. f. A.Y 2024-25)

Name of the Programme	: M.Sc. Computer Science
Program Code	: PSCOS
Class	: M.Sc. (Computer Science)
Semester	: III
Course Type	: Major (Practical)
Course Name	: Data Science & Analytics.
Course Code	: COS-612-MJE (A)
No. of Lectures	: 60
No. of Credits	: 02

Course Objectives:

1. Apply principles of Data Science to the analysis of business problems.

2. Demonstrate Knowledge of statistical data analysis techniques utilized in business decision making.

3. Fundamental concepts of Data Science.

4. Develop python application with visualization effects.

5. Understand programming skills in Python.

Course outcomes:

Students successfully completing this course will be able to:

CO1- Write Python programs to analyze data.

CO2- Evaluate the model performance by applying various algorithms and communicate the observations.

CO3- Apply and analyse data analytical methods for real life problems.

CO4- Students will develop relevant programming abilities.

CO5- Understand a Python program in the context of data analytics

CO6- Students will develop the ability to build and assess data-based models.

CO7- Explore and visualize data using Python.

Assignments
Assignment based on COS-612-MJE(A): Data Science & Analytics

1	Assignment Based on Data Visualization such as Line plot, Scatter plot, Boxplot, Histogram, Bar Chart, Pie Chat etc.
2	Assignment Based on Descriptive Statistics: Measures of Central Tendency and

	Dispersion: Mean, Mode, Median, Range, Standard Deviation, Variance
3	Assignment Based on Correlation and Regression
4	Assignment Based on Data Analytics using Python Tools
5	Assignment Based on Clustering of high dimensional data
6	Assignment Based on Predictive Data Analytics
7	Assignment Based on Data Preprocessing such as Importing and Handling Data Set.
8	Case Studies on Real Life Examples.

References:

11. Data Science and Big Data Analytics Publisher, Wiley, ISBN:9781118876053, 1118876059

12. Cleveland, W . S. (1993). Visualizing data, Murray Hill, NJ: AT&T.

13. Data Analytics for Beginners Publisher, CreateSpace Independent Publishing Platform, ISBN:9781539896739, 1539896730

14. [MD02] Murdoch, D.J. (2002). Drawing a Scatterplot, chance, 13(3),53-55.

Mapping of this course with Programme Outcomes

Course Outcomes	Programme Outcomes (POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	3	3	2	3	1	1	3
CO2	3	3	1	3	3	3	3	1	1	3
CO3	3	3	1	3	3	3	3	1	1	3
CO4	2	3	1	3	2	1	3	1	1	3
CO5	2	2	1	2	3	2	2	1	1	2
CO6	3	3	1	3	3	2	2	1	1	3
CO7	3	3	1	2	3	2	3	1	1	2

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

Course Objectives (CO) and Program Outcomes (PO) Mapping:

Justification of PO1 to ALL COs:

CO1: Directly contributes to students' comprehensive knowledge and understanding by applying foundational theories and methodologies in the context of their field.
CO2: Require a deep understanding of methodologies and key concepts within the field, thereby enhancing postgraduates' comprehensive knowledge and understanding.
CO3: Involves integrating foundational theories and methodologies within a multidisciplinary context, fostering a profound understanding of the field.
CO4: Supports students in understanding Python programs in the context of data analytics, contributing moderately to their comprehensive knowledge and understanding.

CO5: Aids in grasping foundational theories and key concepts, thus moderately enhancing students' comprehensive knowledge and understanding.

CO6: Developing students' ability to apply foundational theories and methodologies within a multidisciplinary context, strongly enhancing their comprehensive knowledge and understanding.

CO7: Facilitates the application of foundational theories and methodologies in real-world contexts, thus strongly enhancing postgraduates' comprehensive knowledge and understanding.

Justification of PO2 to ALL COs:

CO1: Equips postgraduates with practical skills necessary for professional tasks, enhancing their practical, professional, and procedural knowledge.

CO2: Contribute to postgraduates' ability to apply industry standards and regulations effectively in real-world scenarios, strongly enhancing their practical, professional, and procedural knowledge.

CO3: Acquiring practical skills and expertise necessary for professional tasks, thus strongly enhancing postgraduates' practical, professional, and procedural knowledge.

CO4: Supports the acquisition of practical skills necessary for professional tasks, contributing strongly to postgraduates' practical, professional, and procedural knowledge.

CO5: Aids in acquiring practical skills and expertise, contributing moderately to postgraduates' practical, professional, and procedural knowledge.

CO6: Acquiring practical skills necessary for professional tasks, strongly enhancing postgraduates' practical, professional, and procedural knowledge.

CO7: Supports the effective application of industry standards and regulations in real-world scenarios, thus strongly enhancing postgraduates' practical, professional, and procedural knowledge.

Justification of PO3 to ALL COs:

CO1: It may indirectly support fostering innovation and identifying opportunities, its direct relation to cultivating an entrepreneurial mindset or understanding business principles is only partial.

CO2: It may contribute slightly to understanding market dynamics and risk management strategies, but the direct relation to fostering innovation or understanding business principles is limited.

CO3: It may have some relevance to identifying opportunities and understanding market dynamics, but its direct relation to fostering innovation or risk management strategies is partial.

CO4: may indirectly support fostering innovation and understanding business principles, but its direct relation to cultivating an entrepreneurial mindset or risk management strategies is only partial.

CO5: It may indirectly contribute to understanding business principles, but its direct relation to fostering innovation or risk management strategies is limited.

CO6: It may indirectly support identifying opportunities and understanding market dynamics, but its direct relation to fostering innovation or risk management strategies is partial.

CO7: It may indirectly contribute to understanding market dynamics, but its direct relation to fostering innovation or risk management strategies is limited.

Justification of PO4 to ALL COs:

CO1 : Directly contributes to developing specialized technical skills and critical thinking, enhancing postgraduates' proficiency in problem-solving.

CO2 : Require analytical abilities and effective communication skills, directly contributing to postgraduates' proficiency in problem-solving and critical thinking.

CO3 : Developing specialized skills, critical thinking, and problem-solving abilities.

CO4 : enhances postgraduates' proficiency in technical skills and critical thinking, contributing strongly to problem-solving.

CO5 : Aids in developing specialized technical skills and critical thinking, moderately contributing to problem-solving proficiency.

CO6 : Enhances postgraduates' problem-solving abilities and proficiency in technical skills, strongly relating to specialized skills, critical thinking, and problem-solving.

CO7 : Aids in developing specialized technical skills and critical thinking, moderately contributing to problem-solving proficiency.

Justification of PO5 to ALL COs:

CO1 : Correlates with exhibiting observational and inquiry skills, formulating research questions, and utilizing appropriate methodologies for data analysis.

CO2 : Align with effectively reporting findings and adhering to research ethics.

CO3 : Involves observational skills, formulating research questions, and utilizing appropriate methodologies for data analysis.

CO4 : Supports observational and inquiry skills, but may not directly address research ethics or effective reporting of findings.

CO5 : Supports observational and inquiry skills, formulation of research questions, and utilizing appropriate methodologies for data analysis.

CO6 : Relate to formulating research questions, utilizing appropriate methodologies for data analysis, and effectively reporting findings.

CO7 : Supports observational and inquiry skills, formulation of research questions, and effectively reporting findings.

Justification of PO6 to ALL COs:

CO1 : It may indirectly support effective communication and collaboration within diverse teams but may not directly address leadership qualities or facilitating cooperative efforts.

CO2 : Directly align with effectively communicating complex information and collaborating in diverse teams.

CO3 : Involve effective communication, collaboration, and potentially demonstrating leadership qualities to facilitate cooperative efforts.

CO4 : It may not directly address effective communication, collaboration, or leadership qualities.

CO5 : It may indirectly support effective communication and collaboration but may not directly address leadership or facilitation of cooperative efforts.

CO6 : It may indirectly support effective communication and collaboration but may not directly address leadership or facilitation of cooperative efforts.

CO7 : It may indirectly support effective communication and collaboration but may not directly address leadership or facilitation of cooperative efforts.

Justification of PO7 to ALL COs:

CO1 : Demonstrates proficiency in using ICT and adapting to technological advancements.

CO2 : Require proficiency in using appropriate software and adapting to technological advancements.

CO3 : Require proficiency in using ICT and adapting to technological advancements.

CO4 : Demonstrating proficiency in using ICT and adapting to technological advancements.

CO5 : Demonstrates proficiency in using ICT but may not directly address adapting to technological advancements.

CO6 : Demonstrates proficiency in using ICT but may not directly address adapting to technological advancements.

CO7: Demonstrates proficiency in using ICT and adapting to technological advancements.

Justification of PO8 to ALL COs:

CO1: Relate to engaging effectively in multicultural settings, respecting diverse perspectives, or demonstrating empathy.
CO2: It may not directly relate to engaging effectively in multicultural settings, respecting diverse perspectives, or demonstrating empathy.
CO3: It may not directly relate to engaging effectively in multicultural settings, respecting diverse perspectives, or demonstrating empathy.
CO4: It may not directly relate to engaging effectively in multicultural settings, respecting diverse perspectives, or demonstrating empathy.
CO5: It may not directly relate to engaging effectively in multicultural settings, respecting diverse perspectives, or demonstrating empathy.
CO6: It may not directly relate to engaging effectively in multicultural settings, respecting diverse perspectives, or demonstrating empathy.
CO7: It may not directly relate to engaging effectively in multicultural settings, respecting diverse perspectives, or demonstrating empathy.

Justification of PO9 to ALL COs:
CO1: It may not directly relate to embracing ethical and moral values, practicing responsible citizenship, recognizing and addressing ethical issues, or promoting sustainability and environmental conservation.
CO2: It may not directly relate to embracing ethical and moral values, practicing responsible citizenship, recognizing and addressing ethical issues, or promoting sustainability and environmental conservation.
CO3: It may not directly relate to embracing ethical and moral values, practicing responsible citizenship, recognizing and addressing ethical issues, or promoting sustainability and environmental conservation.
CO4: It may not directly relate to embracing ethical and moral values, practicing responsible citizenship, recognizing and addressing ethical issues, or promoting sustainability and environmental conservation.
CO5: It may not directly relate to embracing ethical and moral values, practicing responsible citizenship, recognizing and addressing ethical issues, or promoting sustainability and environmental conservation.
CO6: It may not directly relate to embracing ethical and moral values, practicing responsible citizenship, recognizing and addressing ethical issues, or promoting sustainability and environmental conservation.
CO7: It may not directly relate to embracing ethical and moral values, practicing responsible citizenship, recognizing and addressing ethical issues, or promoting sustainability and environmental conservation.

Justification of PO10 to ALL COs:
CO1: Relates to applying knowledge and skills independently and managing projects effectively.
CO2: Demonstrate responsibility and accountability in work and learning contexts.
CO3: Require autonomy, responsibility, and accountability.
CO4: Contributes to applying knowledge and skills independently and managing projects effectively.
CO5: Indirectly relates to autonomy, responsibility, and accountability but may not directly address project management.
CO6: Demonstrate autonomy, responsibility, and accountability in work and learning contexts.
CO7: Relates to autonomy, responsibility, and accountability but may not directly address project management.

SYLLABUS (CBCS as per NEP 2020) FOR M. Sc. (Computer Science)

(w. e. from June,2024)

Name of the Programme	: M.Sc. Computer Science
Programme Code	: PSCOS
Class	: M.Sc. (Computer Science) II
Semester	: III
Course Type	: Major (Elective) (TH)
Course Name	: Soft Computing
Course Code	: COS-611-MJE (B)
No. of Lectures	: 30 Hours
No. of Credits	: 02

Prerequisites: Probability, First Order Mathematical Logic, Classical Logic, Linear algebra and Calculus.

Objective:

1) To understand the concepts of how an intelligent system work and its brief development process.
2) Be familiar with design of various neural networks & fuzzy logic & Learn genetic programming.

Learning Outcome:

CO1: Describe human intelligence and AI.
CO2: Know intelligent system works.
CO3: Apply basics of Fuzzy logic and neural networks.
CO4: Know and Apply ideas of fuzzy sets, fuzzy logic and use of human experience relate   with neural networks, generalize appropriate rules for inference systems.
CO5: Deploy the genetic algorithms and other randomises arch procedures.
CO6: Develop some familiarity with current research problems and research methods in Soft Computing Techniques.
CO7: Able to select a proper pattern matching algorithm for given problem.

Units	Units & Contents	No. Of Lectures
Unit I	**1.Introduction to Soft Computing** • Concept of computing system • "Soft" Vs. "Hard" computing • Characteristics of soft computing • Some application of soft computing techniques	06
Unit II	**2.FuzzyLogic** • Uncertainty and information • Fuzzy set and membership • Chance versus Fuzziness	10

	• Classical Sets, Fuzzy Sets • Cartesian Product • Crisp Relations • Fuzzy relations • Tolerance and equivalence Relations, Fuzzy Tolerance and equivalence Relations • Value assignments, Other Form soft the Composition Operations • Features of the membership Function • Various forms, Fuzzification, Defuzzification to Crisp sets • λ-Cuts for fuzzy Relations, Defuzzification to Scalars	
Unit III	**3.FuzzySystem** • Fuzzy Logic • Approximate Reasoning, Others of implication operations. • Natural Language, Linguistic Hedges • Fuzzy (Ruled-Based) system • Graphical technique of inference • Membership value assignment-Intuition, Inference.	08
Unit IV	**4.NeuralNetwork** • Biological neurons and its working. • Simulation of biological neurons to problem solving. • Different ANNs architectures. • Training techniques for ANNs. • Applications of ANNs to solve some real-life problems.	06

Reference Books

1. Fuzzy Logic with Engineering Applications, 3rd Edition By Timothy Ross.
2. Neural Networks By Satish Kumar, Tata McGraw Hill
3. Introduction to Soft Computing by Deepa & Shivanandan, Wiley Publication
4. Genetic Algorithms in Search, Optimization and Machine Learning By David E. Goldberg,Pearson Education.

Mapping of this course with Programme Outcomes

Course Outcomes	Programme Outcomes (POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	3	2	2	2	2	3	3
CO2	3	3	3	3	3	2	3	2	3	3
CO3	3	3	3	3	3	2	3	2	3	2
CO4	3	3	3	3	3	2	3	2	3	3
CO5	2	3	3	3	3	2	3	-	3	2
CO6	3	3	3	3	3	2	3	2	2	2
CO7	2	3	3	3	3	2	3	2	2	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

Justification of PO1 to ALL COs:
Understanding human intelligence and AI is fundamental to gaining comprehensive knowledge and understanding in the field of artificial intelligence.

Justification of PO2 to ALL COs:
Developing familiarity with current research problems and methods is important for staying updated with advancements in AI technology, contributing to professional knowledge.

Justification of PO3 to ALL COs:
The ability to select appropriate pattern matching algorithms is a practical skill necessary for professionals working with AI systems. It directly contributes to their ability to design and implement effective AI solutions.

Justification of PO4 to ALL COs:
Developing familiarity with current research problems and methods in Soft Computing Techniques allows professionals to stay updated with the latest advancements in AI, fostering an entrepreneurial mindset and encouraging innovation in AI-related businesses. It directly contributes to their ability to identify opportunities and develop innovative solutions.

Justification of PO5 to ALL COs:
The ability to select appropriate pattern matching algorithms is a specialized skill that directly contributes to problem-solving in AI applications.

Justification of PO6 to ALL COs:
Knowing and applying ideas of fuzzy sets, fuzzy logic, and neural networks involves collaboration with experts in these fields. It also requires effective communication of technical concepts to convey ideas and solutions related to AI systems.

Justification of PO7 to ALL COs:
Knowing how intelligent systems work is directly relevant to digital proficiency and technological skills. It enables individuals to understand and utilize AI technologies effectively.

Justification of PO8 to ALL COs:
Understanding human intelligence and AI may contribute to multicultural competence and empathy by fostering an understanding of diverse perspectives and the impact of AI on different cultures and societies.

Justification of PO9 to ALL COs:
Deploying genetic algorithms and other procedures may indirectly relate to ethical practices by considering the ethical implications of algorithmic decision-making and ensuring fairness and transparency in AI systems.

Justification of PO10 to ALL COs:
Understanding human intelligence and AI is foundational for developing autonomy, responsibility, and accountability in the use of AI technologies. It enables individuals to recognize the ethical implications and potential consequences of AI systems.

SYLLABUS (CBCS as per NEP 2020) FOR M. Sc. (Computer Science)
(w. e. from June,2024)

Name of the Programme	: M.Sc. Computer Science
Programme Code	: PSCOS
Class	: M.Sc. (Computer Science) II
Semester	: III
Course Type	: Major (Elective)(PR)
Course Name	: Lab Course on COS-611-MJM(B)
Course Code	: COS-612-MJE(B)
No. of Lectures	: 60 Hours
No. of Credits	: 02

Course Objective:
  1. To introduce the concepts in Soft Computing such as Artificial Neural
  Networks, Fuzzy logic-based systems and their hybrids.
  2. Solving single-objective optimization problems .
  3.Soloving multi-objective optimization problems using Evolutionary algorithms.
  4.Applications of Soft computing to solve problems in varieties of application domains.

Course Outcome:
  CO1: Design hybrid system to revise the principles of soft computing in various applications.
  CO2: Recognize the feasibility of applying a soft computing methodology for a particular
         problem
  CO3: Implement, evaluate and compare solutions by various soft computing approaches for
         finding the optimal solutions.
  CO4: Design the methodology to solve optimization problems using fuzzy logic, genetic
         algorithms and neural networks.
  CO5: Develop intelligent systems leveraging the paradigm of soft computing techniques.
  CO6: Analyze various neural network architectures.
  CO7: Learn soft computing techniques and their applications.

Topic No.	Topics
1	Performing Union, Intersection and Complement operations.
2	Implementation of De-Morgan's Law
3	Plotting various membership functions
4	Using fuzzy toolbox to model tips value
5	Implementation of Fuzzy Inference System
6	Simple fuzzy set operations
7	Using Hopfield network with no self-connection
8	Finding weight matrix of Hetero-Associative neural net for mapping of vectors

Mapping of this course with Programme Outcomes

Course Outcomes	Programme Outcomes (POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	2	2	2	2	3
CO2	2	3	2	3	3	2	3	-	2	3
CO3	3	3	3	3	3	2	2	2	2	3
CO4	3	3	3	3	3	2	3	-	2	3
CO5	3	3	3	3	3	2	3	2	2	3
CO6	3	3	2	3	3	2	3	2	-	-
CO7	3	3	3	3	3	2	3	-	2	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

Justification of PO1 to ALL COs:

Designing hybrid systems involves a deep understanding of soft computing principles and their application in real-world scenarios, as it demonstrates comprehensive knowledge and understanding of soft computing techniques.

Justification of PO2 to ALL COs:

Recognizing the feasibility of applying soft computing methodologies involves assessing the practical applicability of these techniques to specific problems. It requires professional judgment and procedural knowledge to determine the suitability of soft computing approaches.

Justification of PO3 to ALL COs:

Implementing, evaluating, and comparing solutions using soft computing approaches involves innovation in selecting and applying the most effective techniques for solving business problems. It requires understanding the business context to determine the optimal solution.

Justification of PO4 to ALL COs:

Designing methodologies to solve optimization problems with soft computing techniques involves entrepreneurial mindset in identifying innovative approaches to tackle optimization challenges. It also requires understanding the business context to ensure the developed methodologies align with business goals.

Justification of PO5 to ALL COs:

Learning soft computing techniques and their applications requires research to study the underlying principles and methodologies. Analytical reasoning is necessary to understand the concepts and their practical implications. Ethical conduct is relevant to ensure academic integrity and honesty in the learning process.

Justification of PO6 to ALL COs:

Communication skills are important in conveying the feasibility assessment of applying soft computing methodologies to relevant stakeholders or team members. Collaboration may be required to gather insights from various perspectives on the problem's suitability for soft computing

approaches. Leadership may play a role in guiding discussions and decision-making processes regarding the feasibility assessment.

Justification of PO7 to ALL COs:

Designing methodologies for solving optimization problems involves leveraging digital proficiency and technological skills to utilize software tools and platforms for implementing and testing different soft computing techniques.

Justification of PO8 to ALL COs:

Learning soft computing techniques and their applications may indirectly involve exposure to diverse perspectives and understanding the broader societal implications of technology. This can contribute to multicultural competence and inclusive spirit.

Justification of PO9 to ALL COs:

Recognizing the feasibility of applying soft computing methodologies may indirectly involve considering ethical implications and environmental awareness related to the problem domain.

Justification of PO10 to ALL COs:

Implementing, evaluating, and comparing solutions involves autonomy in decision-making and taking responsibility for the performance of the solutions.

SYLLABUS (CBCS as per NEP 2020) FOR M. Sc. (Computer Science)
(w. e. from June,2024)

Name of the Programme   : M.Sc. Computer Science
Programme Code   : PSCOS
Class   : M.Sc. (Computer Science) II
Semester   : III
Course Type   : Research Project (RP)
Course Name   : Research Project in Computer Science
Course Code   : COS-621-RP
No. of Lectures   : 60 Hours
No. of Credits   : 04

Teaching Scheme: 4 hours/week

Workload: 1. One mentor (Project Guide) to be assigned for 10/12 students.

2. 4 hours /week to be allotted for 10/12 students

Guidelines:

• Each student must individually complete Research project in the 3rd semester.

• College should assign a student mentor to student batch. The mentor will monitor the progress of

   the student throughout the semester for continuous assessment.

• There will be continuous assessment of the work done by the student during the period.

• Continuous assessment guidelines:

   1. Student should submit a weekly report in the college to the mentor.

   2. The report should contain the following details:

      Name of student, project title, daily activities and results, proposed work for next
      week.

   3. The weekly report should be duly signed by the student and Project Guide.

   4. Student Mentor should maintain weekly attendance record for every student.

   5. Continuous presentations should be conducted for each Student.

   6. Student Mentor should give feedback from overall performance of the student.

• At the end of the Semester, each student should prepare a report which should conform to

   international academic standards.

The report should follow the style in academic journals and books, with contents such as:

Abstract, background, aim, design and implementation, testing, conclusion and full references, Tables and figures should be numbered and referenced to in the report.

Recommended Documentation contents:
Title page
Company / Institute certificate
Internship completion certificate

Abstract
Introduction: - -motivation, -problem statement. -purpose/objective and goals, -literature survey, -project scope and limitations.

System analysis: -
 -Comparative study of Existing systems, - scope and limitations of existing systems, -project perspective, features, - stakeholders, -Requirement analysis, - Functional requirements, performance requirements, security requirements etc.

System Design: -
- Design constraints, - System Model: UML diagrams, - Data Model, -User interfaces.

Implementation details: - -Software/hardware specifications, etc.

Reports

Testing: - Test Plan, Black Box Testing or Data Validation Test Cases, White Box Testing or Functional Validation Test cases and results

Conclusion and Recommendations
Future Scope
Bibliography and References

Prerequisites :
- The Project can be platform, language and technology independent.
- Project will be evaluated by the project guide.
- Assessment will be done weekly in the respective batch guide.
- Evaluation will be on the basis of weekly progress of project work, progress report, oral, results and documentation and demonstration.
- You should fill your status of project work on the progress report and get the signature of project guide regularly.
- Progress report should sharply focus how much time you have spent on specific task? You should keep all sign progress report.
- Project will not be accepted, if progress report is not submitted and all the responsibilities remain with student.

The format of Progress Report is:

Roll No. & Name of Student:	
Title of the Project:	
Project Guide Name:	

Sr. No.	Date	Details of Project Work	Project Guide Sign (With Date)
1			
2			
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12			

Head
Department of Computer Science

Examination Pattern / Evaluation Pattern

Teaching and Evaluation (for Major, Minor, AEC, VEC, IKS courses)

Course Credits	No. of Hours per Semester Theory/Practical	No. of Hours per Week Theory/Practical	Maximum Marks	CE 40 %	ESE 60%
1	15 / 30	1 / 2	25	10	15
2	30 / 60	2 / 4	50	20	30
3	45 / 90	4 / 6	75	30	45
4	60 / 120	4 / 8	100	40	60

Teaching and Evaluation (for VSC, SEC & CC courses)

- Evaluation to be done by Internal & External Experts
- No descriptive end semester written examination
- Evaluation to be done at Department level preferably prior to commencement of Theory /Practical Examinations
- Evaluation to be done on the Skills gained by student