Anekant Education Society's

Tuljaram Chaturchand College, Baramati

(Empowered Autonomous)

Two Year Post Graduate Degree Program in Computer Science

(Faculty of Science & Technology)

CBCS Syllabus

M.Sc. (Computer Science) Part-I Semester -I

For Department of Computer Science

Tuljaram Chaturchand College, Baramati

Choice Based Credit System Syllabus (2026 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2026-2027

(Eligibility: B.Sc. Computer Science)

Title of the Programme: M.Sc. (Computer Science) (2026 Pattern)

Preamble

AES's TuljaramChaturchand 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-I 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: Enrich the knowledge in the areas like Artificial Intelligence, Web Services, Cloud Computing, Paradigm of Programming language, Design and Analysis of Algorithms, Database Technologies Advanced Operating System, Mobile Technologies, Software Project Management and core computing subjects. Choose to study any one subject among recent trends in IT provided in the optional subjects.

PSO2: Students understand all dimensions of the concepts of software application and projects.

PSO3: Students understand the computer subjects with demonstration of all programming and theoretical concepts with the use of ICT.

PSO4: Developed in-house applications in terms of projects.

PSO5: Interact with IT experts & knowledge by IT visits.

PS06: Get industrial exposure through the 6 months Industrial Internship in IT industry.

PS07: To make them employable according to current demand of IT Industry and responsible citizen. PS08: Aware them to publish their work in reputed journals.

Anekant Education Society's
Tuljaram Chaturchand College, Baramati
(Empowered Autonomous)
Board of Studies (BOS) in Computer Science

From 2025-26 to 2027-28

Sr.No.	Name	Designation
1.	Dr. Upendra D. Choudhari	Chairman
2.	Dr. Vilas V. Kardile	Member
3.	Mr. Abhijeet D. Mankar	Member
4.	Mrs. Prajakta P. Kulkarni	Member
5.	Mrs. Asmita A. Bhagat	Member
6.	Mr. Rahul A. Shah	Member
7.	Mr. Purushottam S. Dixit	Member
8.	Dr. Shashikant C. Nakate	Member
9.	Mrs. Poornima C. Swami	Member
10.	Mrs. Komal M. Theurkar	Member
11.	Mr. Swapnil Chemte	Member
12.	Mrs. Lata S. Jadhav	Member
13.	Mrs. Jyostna P. Gharge	Member
14.	Ms. Vaishnavi K. Shivarkar	Member
15.	Mrs. Vrushali Y. Shirkande	Member
16.	Dr. Manisha Bharambe	Vice-Chancellor Nominee
17.	Dr. Sudhakar Bhoite	Expert from other University
18.	Dr. Ulhas S. Patki	Expert from other University
19.	Mr. Yadav Preetam	Representative from Industry/Corporate Sector
20.	Mr. Bhaskar Ranaware	Member of the college Alumni
21.	Ms. Sakshi Vargar	Student Representative
22.	Mr. Adesh Jagtap	Student Representative

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Empowered Autonomous)

Credit Distribution Structure for (M.Sc. (Computer Science)) Part-I (2026 Pattern)

Year	Level	Sem.	Major		Research Methodology (RM)	OJT/ FP	RP	Cum. Cr.
			Mandatory	Electives				
I	6.0	Sem-I	COS-501-MRM: Cryptography and Cyber Forensics (**Credit 04**) COS-502-MRM: Design and Analysis of Algorithms (**Credit 04**) COS-503-MRM: Software Metrics and Project Management (**Credit 02**) COS-504-MRM: Front End Stack Practical (PR) (**Credit 02**) COS-505-MRM: Database Technologies (PR) (**Credit 02**)	COS-506-MJE(A): Basic Dot Net (**Credit 02**) OR COS-506-MJE(B) : Cloud Computing (**Credit 02**) COS-507-MJE(A):Lab Course based on COS-506-MJE(A) (PR) (**Credit 02**) OR COS-507-MJE(B):Lab Course based on COS-506-MJE(B) (PR) (**Credit 02**)	COS-508-RM: Research Methodology in Computer Science (**Credit 04**)	--	--	**22**
		Sem- II	COS-551-MRM: Digital Image Processing (**Credit 04**) COS-552-MRM: Data Mining and Data Warehousing (**Credit 04**) COS-553-MRM: Artificial Intelligence (**Credit 02**) COS-554-MRM: Back End Stack Practical (PR) (**Credit 02**) COS-555-MRM: Python Programming (PR) **(Credit 02)**	COS-556-MJE (A): Advanced Dot Net(**Credit 02**) OR COS-556-MJE(B): Mobile Application Development (**Credit 02**) COS-557-MJE(A): Lab Course based on COS-556-MJE(A) (PR) (**Credit 02**) OR COS-557-MJE(B): Lab Course based on COS-556-MJE(A) (PR) (**Credit 02**) **(Credit 02)**	--	COS-558-OJT (**Credit 04**)	--	**22**
				*** 1 Credit = 15 Hr.**				
Cum. Cr.			**28**	**8**	**4**	**4**	**--**	**44**

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

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Course Structure for (M.Sc. (Computer Science) Part-I (2026 Pattern)

Sem	Course Type	Course Code	Title of Course	TH/PR	No. of Credits
I	Major (Mandatory)	COS-501-MRM	Cryptography and Cyber Forensics	Theory	4
		COS-502-MRM	Design and Analysis of Algorithms	Theory	4
		COS-503- MRM	Software Metrics and Project Management	Theory	2
		COS-504- MRM	Front end stack Practical	Practical	2
		COS-505- MRM	Database Technologies	Practical	2
	Major (Elective)	COS-506-MJE (A)	Basic Dot Net	Theory (Any One)	2
		COS-506-MJE (B)	Cloud Computing		
		COS-507-MJE (A)	Lab Course based on COS-506-MJE (A)	Practical (Any One)	2
		COS-507-MJE (B)	Lab Course based on COS-506-MJE (B)		
	RM	COS-508-RM	Research Methodology in Computer Science	Theory	4
			Total Credits:		**22**
II	Major (Mandatory)	COS-551-MRM	Digital Image Processing	Theory	4
		COS-552-MRM	Data Mining and Data Warehousing	Theory	4
		COS-553- MRM	Artificial Intelligence	Theory	2
		COS-554- MRM	Back-end stack Practical	Practical	2
		COS-555- MRM	Python Programming	Practical	2
	Major (Elective)	COS-556-MJE (A)	Advanced Dot Net	Theory (Any One)	2
		COS-556-MJE (B)	Mobile Application Development		
		COS-557-MJE (A)	Lab Course based on COS-556-MJE (A)	Practical (Any One)	**2**
		COS-557-MJE (B)	Lab Course based on COS-556-MJE (B)		
	On Job Training (OJT)	COS-558-OJT	On Job Training	**Theory**	**4**
	Total Credit Semester – II				**22**
	Cumulative Credits of Semester – I and II				**44**

SYLLABUS (CBCS-2026 pattern as per NEP 2020) FOR M. Sc. (Computer Science) (2026 Pattern) (w. e. f A.Y 2026-27)

Name of the Programme	: M.Sc. Computer Science
Program Code	: PSCOS
Class	: M.Sc. (Computer Science)
Semester	: I
Course Type	: Major Mandatory (TH)
Course Name	: Cryptography and Cyber Forensics
Course Code	: COS-501-MRM
No. of Lectures	: 60
No. of Credits	: 04

Prerequisites:

1. Basic Knowledge of Computer Networks
2. Fundamentals of Operating Systems
3. Basic Programming Skills
4. Mathematical Foundations

Course Objectives:

1. To enable students to get sound understanding of Info-Sys-Security, Network Security, Cryptography and cyber forensics.
2. To equip with knowledge and skills necessary to support for their career in Network Security.
3. To encourage them to do further academic studies/research in this area.
4. To develop IT professionals skilled in information/network security and forensic analysis of compromised systems and who are efficient in documentation pertaining to cyber forensic analysis to be provided to the courts of law.
5. Understand principles of web security and to guarantee a secure network by monitoring and analysing the nature of attacks through cyber/computer forensics software/tools.
6. Understand key terms and concepts in Cryptography, Governance and Compliance.
7. To make the student learn different encryption techniques along with hash functions, MAC, digital signatures and their use in various protocols for network security and system security.

Course Outcomes:

CO1. Learn the security concepts and techniques.
CO2. In future these experts will be an asset to this country for serving in the fields of information security and digital forensics.
CO3. Understand and analyse data encryption standard.
CO4. Analyse and evaluate the cyber security needs of an organization.
CO5. Determine and analyse software vulnerabilities and security solutions to reduce the risk

of exploitation.

CO6. Implement cyber security solutions and use of cyber security, information assurance, and cyber/computer forensics software/tools.

CO7. Implement various networking protocols.

Unit	Title and Contents	No. of Lectures
1.	**Introduction to Security, Cryptography and Techniques:** 1.1. Need for Security 1.2. Security Approaches 1.3. Principles of Security 1.4. Types of Attacks 1.5. Introduction to Cryptography 1.6. Plain Text and Cipher Text 1.7. Substitution Techniques, Transposition Techniques 1.8. Encryption and Decryption 1.9. Symmetric and Asymmetric key cryptography, Steganography	**09**
2.	**Symmetric Key Algorithms and AES:** 2.1 Algorithm Types and Modes 2.2 Overview of Symmetric Key Cryptography 2.3 DES, IDEA, Blowfish	**09**
3.	**Asymmetric Key Algorithms, Digital Signature and RSA:** 3.1 Brief History and Overview of Asymmetric Key Cryptography 3.2 RSA Algorithm 3.3 Comparison: Symmetric vs. Asymmetric Key Algorithms 3.4 Digital Signature	**06**
4.	**Digital Certificates and Public Key Infrastructure (PKI):** 4.1 Introduction to Digital Certificates 4.2 Private key management 4.3 Certificate Lifecycle Management 4.4 Applications and Security Issues	**04**
5.	**Introduction to Cyber forensics** 5.1 Information Security Investigations, Corporate Cyber Forensics 5.2 Scientific method in forensic analysis, investigating large scale Data breach cases 5.3 Analyzing malicious software 5.4 Types of Computer Forensics Technology 5.5 Types of Militaries, Law Enforcement & Business Forensic Technology 5.6 **Specialized Forensic Techniques & Hidden Data** 5.7 **Security Technologies & Protection Methods** 5.8 Spyware and Adware, Encryption Methods and Vulnerabilities 5.9 Protecting Data from Being Compromised Internet Tracing Methods Security and Wireless Technologies, Avoiding Pitfalls with Firewalls Biometric security Systems.	**12**
6.	**Types of Computer Forensics Systems:** 6.1 Internet Security Systems, Intrusion Detection Systems 6.2 Storage Area Network Security Systems, Network Disaster Recovery Systems, 6.3 Satellite Encryption Security Systems, Instant Messaging (IM)	**10**

	Security Systems, 6.4 Net Privacy Systems, Identity Management Security Systems 6.5 Identity Theft, Router Forensics 6.6 Cyber forensics tools and case studies 6.7 Ethical Hacking: Essential Terminology, Windows Hacking, Malware, Scanning, Cracking	

References:

1. Atul Kahate, "Cryptography and Network Security", Second/Thirtd/Forth Edition, McGraw Hill Publication.
2. John R.Vacca, "Computer Forensics: Computer Crime Scene Investigation",2nd Edition, Charles River Media,2005
3. Ravi Kumar & B Jain, "Cyber Forensics-Concepts and Approaches", Icfai University Press,2006
4. Christof Paar, Jan Pelzl, "Understanding Cryptography: A Textbook for Students and Practitioners", Second, Edition, Springer's,2010
5. "Live Hacking: The Ultimate Guide to Hacking Techniques & Countermeasures for Ethical Hackers & IT Security Experts", Ali Jahangiri, First edition,2009
6. Kizza, Springer, "Computer Network Security" Harrington, Elsevier

NOTE:50 LECTURES FOR CURRICULUM(TEACHING) & 10 LECTURES FOR LEARNING

CO-PO Mapping:

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

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

1 Justification of PO1 to ALL COs :

CO1- Learning security concepts and techniques builds core advanced disciplinary knowledge in cyber security.

CO2- Contributing to national information security services reflects application of disciplinary knowledge.
CO3- Analysing Data Encryption Standard develops deep conceptual and technical expertise in cryptography.
CO4- Evaluating organizational cyber security needs requires advanced analytical and domain-specific knowledge.
CO5- Identifying software vulnerabilities demonstrates higher-level problem-solving and originality in security.
CO6- Implementing cyber security and forensic tools reflects applied advanced disciplinary competence.
CO7-implementing networking protocols supports applied technical knowledge in security systems.

2 Justification of PO2 to ALL COs :

CO1- Learning security concepts build analytical understanding but involve limited independent research complexity.
CO2- Becoming an expert contributes indirectly to research ability, but the outcome focuses more on professional contribution than analytical research.
CO3- Analyzing Data Encryption Standard requires deep analytical thinking and understanding of computational complexity.
CO4- Evaluating cyber security needs of an organization demands critical analysis, research, and problem-solving skills.
CO5- Determining software vulnerabilities involves investigative research and complexity analysis of security threats.
CO6- Implementation of security solutions applies analytical knowledge but emphasizes practical execution over research depth.
CO7- Implementing networking protocols requires understanding of technical complexity but limited independent research analysis.

3 Justification of PO3 to ALL COs :

CO1- Learning security concepts provides foundational knowledge required to solve security-related problems in new scenarios.
CO2- Being an asset in the field supports problem-solving ability, but the outcome focuses more on professional growth than direct problem-solving skills.
CO3- Analyzing Data Encryption Standard develops the ability to solve complex cryptographic problems in different contexts.
CO4- Evaluating cyber security needs of organizations involves identifying and solving real-world security challenges in varied environments.
CO5- Determining vulnerabilities and proposing security solutions directly addresses practical problem-solving in emerging threat scenarios.

CO6- Implementing cyber security and forensic tools requires applying knowledge to solve technical issues in new and dynamic contexts.

CO7- Implementing networking protocols supports technical problem-solving, though mostly within predefined standards and frameworks.

4 Justification of PO4 to ALL COs :

CO1- Learning security concepts and techniques develops technical foundation but involves limited advanced scientific reasoning.

CO2- Serving in the field reflects professional competence, but technical mastery is indirectly addressed.

CO3- Analyzing Data Encryption Standard requires strong scientific reasoning and deep technical understanding of cryptographic algorithms.

CO4- Evaluating cyber security needs demands systematic technical analysis and application of scientific security principles.

CO5- Identifying vulnerabilities and proposing security solutions requires high-level technical expertise and logical reasoning.

CO6- Implementing cyber security and forensic tools demonstrates applied technical mastery and scientific problem-solving skills.

CO7- Implementing networking protocols shows technical competence but follows established standards rather than advanced reasoning.

5 Justification of PO5 to ALL COs :

CO1- Learning security concepts contribute indirectly to communication, as understanding is required before explaining ideas.

CO2- Serving in information security and digital forensics requires effective communication of technical findings to stakeholders.

CO3- Analyzing encryption standards supports the ability to clearly interpret and communicate technical cryptographic concepts.

CO4- Evaluating organizational cyber security needs requires presenting risk assessments and recommendations clearly to management.

CO5- Reporting software vulnerabilities and security solutions demands precise technical documentation and professional communication.

CO6- Using cyber forensic tools involves preparing structured reports and presenting digital evidence effectively.

CO7- Implementing networking protocols requires coordination and technical communication within teams.

6 Justification of PO6 to ALL COs :

CO1- Learning security concepts build awareness of ethical responsibilities in protecting information systems.

CO2- Serving in information security and digital forensics requires high ethical standards and professional judgment in handling sensitive data.

CO3- Analyzing encryption standards promotes understanding of secure practices and responsible use of cryptographic techniques.
CO4- Evaluating organizational cyber security needs involves ethical decision-making to safeguard privacy and comply with legal standards.
CO5- Identifying vulnerabilities and recommending solutions requires professional integrity and responsible disclosure practices.
CO6- Implementing cyber security and forensic tools demands ethical handling of digital evidence and adherence to legal frameworks.
CO7- Implementing networking protocols requires responsible configuration and compliance with security and professional standards.

7 Justification of PO7 to ALL COs :

CO1- Learning security concepts build foundational knowledge that encourages continuous self-learning in evolving security domains.
CO2- Becoming an expert in information security and digital forensics requires continuous upskilling and lifelong learning due to rapidly changing technologies.
CO3- Analyzing encryption standards promotes independent exploration of advanced cryptographic techniques.
CO4- Evaluating cyber security needs of organizations requires staying updated with emerging threats and evolving security frameworks.
CO5- Identifying vulnerabilities and proposing solutions demands continuous learning to address new attack techniques and security tools.
CO6- Implementing cyber security and forensic tools requires ongoing practice and adaptation to new technologies and investigative methods.
CO7- Implementing networking protocols supports professional growth but generally follows established standards rather than independent learning initiatives.

8 Justification of PO8 to ALL COs :

CO1- Learning security concepts build essential skills that enhance employability in cyber security roles.
CO2- Developing expertise in information security and digital forensics directly supports career opportunities and professional growth.
CO3- Analyzing encryption standards equips students with specialized technical skills highly demanded in industry and security innovation.
CO4- Evaluating organizational cyber security needs prepares students for consultancy roles and entrepreneurial ventures in security services.
CO5- Identifying vulnerabilities and designing security solutions fosters innovation and supports employability in cyber defense domains.
CO6- Implementing cyber security and forensic tools develops practical industry-ready skills and opportunities for security-based startups.

CO7- Implementing networking protocols strengthens technical competence relevant to employment, though less directly linked to entrepreneurship.

(w. e. f A.Y 2026-27)

Name of the Programme	: M.Sc. Computer Science
Program Code	: PSCOS
Class	: M.Sc. (Computer Science)
Semester	: I
Course Type	: Major Mandatory (TH)
Course Name	: Design& Analysis of Algorithms
Course Code	: COS-502-MRM
No. of Lectures	: 60
No. of Credits	: 4

Prerequisites:

A. Course Objectives: Students successfully completing this course will be able to

1. Understands basic algorithm analysis techniques & the use O-asymptotic notation.
2. Understands different design strategies.
3. Understand the use of data structure proving algorithm performance.
4. Understand classical problems and solutions.
5. Learn a variety of useful algorithms.
6. Understand classification of problems.

B. Course Outcomes:

CO1-Understand Tree Traversal method & Greedy algorithms.
CO2-Understand algorithm design techniques.
CO3-Learn how to analyse algorithm and estimate their worst case & average case behaviour.
CO4-Identify & understand various time & space complexities of various algorithms.
CO5-Find optimal solution by applying various methods.
CO6-Design optimal solution by applying various methods.
CO7-Learn how to apply their theoretical knowledge in practice.

Unit	Title and Contents	No. of lectures
1.	**Analysis & Design Strategies** 1.1Fundamentals of Algorithms • Algorithm definition, Recursive algorithms (Tower of Hanoi) 1.2Complexity Analysis • Time complexity • Space complexity • Asymptotic Notations (Big O, Omega, Theta) • Performance Cases (Worst Case, Best Case, Average Case) 1.3Sorting Algorithms	**10**

	• Insertion sort and Heap Sort. 1.4Divide & Conquer Methodology • Binary search 1.5Advanced sorting Algorithms • Merge Sort • Quick Sort 1.6Matrix Operations • Strassen's Matrix Multiplication	
2.	**Greedy Method** 1.1 Knapsack problem 1.2Scheduling and Storage • Job sequencing with deadlines • Optimal storage on Tapes • Optimal Merge Pattern 1.3Minimum Spanning Tree • Kruskal's Algorithm • Prim's Algorithm 1.4Data compression • Huffman Coding	**10**
3.	**Dynamic programming** 1.1Dynamic Programming Principles • Matrix chain Multiplication • Longest Common Subsequence (LCS) • String Editing • 0/1knapsack problem • Travelling salesperson problem 1.2Shortest Path Algorithms • Dijkstra's Algorithm • Bellman-Ford Algorithms • All-pairs shortest path (Floyd-Warshall Algorithm)	**10**
4.	**Decrease and conquer** 1.1Graph Traversal Techniques • Breadth-First Search (BFS) • Depth-First Search (DFS) 1.2Graph Ordering and Structure • Topological Sort • Strongly Connected Components	**6**

5.	**Backtracking, Branch and Bound Techniques** 1.1Backtracking Technique • Concept, State-Space Tree, N-Queens Problem, Sum of Subsets, Graph Coloring, Hamiltonian Cycles 1.2Brach & Bound Technique • FIFO, LIFO,0/1 Knapsack, TSP Problem.	**8**
6.	**Transform and Conquer, Problem Classification** 1.1Transform and Conquer • Horner's Rule, Binary Exponentiation 1.2Problem Reduction 1.3Problem Classification • Non-Deterministic Algorithm, Class P, Class NP, NP-Hard, NP-Complete 1.4Cook's Theorem	**6**

NOTE:50LECTUREFORCURRICULUM(TEACHING) 10 LECTURES FOR LEARNING

Reference Books:

- Ellis Horowitz, Sartaj Sahni &Sangu the var Rajasekaran, Computer Algorithms, Galgotia
- T.Cormen, C.Leiserson,& R.Rivest, Algorithms, MITPress,19901
- A.Aho, J.Hopcroft,& J.Ullman, TheDesign and Analysis of Computer Algorithms, AddisonWesley,1974
- Donald Knuth, The Art of Computer Programming (3 vols.,various editions,1973-81), Addison Wesley
- Steven Skiena, The Algorithm Manual, Springer ISBN:9788184898651
- Jungnickel, Graphs, Networks and Algorithms, Springer, ISBN:3540219056

Mapping of this course with Programme Outcomes

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

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

Justification of PO1 to ALL COs:

PO1 – Advanced Disciplinary Knowledge

Strongly related (3) to CO1–CO6 as algorithm design, analysis, and optimization build advanced subject knowledge; moderately related (2) to CO7 as practical application supports but does not fully define advanced theory.

PO2 – Research, Analysis & Complexity

Strong relation (3) with CO2–CO7 since hypothesis formation, algorithm analysis, and experimentation require design and analytical skills; moderately related (2) to CO1 as traversal and greedy basics support research foundation.

PO3 – Problem Solving in New Contexts

Strong relation (3) with CO2, CO5, CO6, CO7 due to designing and applying optimal solutions in new contexts; moderate (2) with CO1, CO3, CO4 as they support but are more foundational.

PO4 – Technical Mastery & Scientific Reasoning

Strong (3) with CO3, CO4, CO6, CO7 as complexity analysis and implementation require technical depth; moderate (2) with CO2 & CO5; partial (1) with CO1 since traversal basics need limited advanced tools.

PO5 – Integrated Communication

Moderate (2) relation with CO3, CO4, CO6, CO7 where explaining analysis and solutions is required; partial (1) for others as communication is indirect.

PO6 – Ethical, Social & Professional Judgment

Partial (1) relation with most COs since ethics is not directly central in algorithm design; moderate (2) with CO7 as practical application involves responsible implementation.

PO7 – Autonomous & Lifelong Learning

Strong (3) with CO3, CO4, CO6, CO7 because continuous improvement in algorithm efficiency and implementation requires self-learning; moderate (2) for others.

PO8 – Employability, Innovation & Entrepreneurship

Strong (3) with CO5,CO6, CO7 since designing optimal and practical solutions enhances employability; moderate (2) with CO1–CO4 as foundational skills support innovation.

SYLLABUS (CBCS-2026 Pattern as per NEP 2020) FOR M. Sc. (Computer Science)
(w. e. f A.Y 2026-27)

Name of the Programme	: M.Sc. Computer Science
Program Code	: PSCOS
Class	: M.Sc. (Computer Science)
Semester	: I
Course Type	: Major Mandatory (TH)
Course Name	: Software Metrics and Project Management
Course Code	: COS-503-MRM
No. of Lectures	: 30
No. of Credits	: 2

A. Prerequisites:

Knowledge of Software Engineering fundamentals, SDLC models, basic programming, statistics, DBMS, project management concepts, and quality assurance principles.

B. Course Objectives:

1. Understand the fundamentals of Software Project Management**,** including project life cycle, organizational structures, and project planning activities.
2. Apply project planning, scheduling, estimation, and risk management techniques.
3. Evaluate software projects using cost–benefit analysis and effort estimation techniques.
4. Develop activity plans using network models and scheduling methods.
5. Implement software quality standards such as ISO 9126 and Capability Maturity Model (CMM).
6. Use software project metrics for measurement, productivity assessment, and effective project control.

C. Course Outcomes:

At the end of the course, students will be able to:

CO1-Explain software project management concepts, project life cycle models, and organizational structures.

CO2-Develop project plans including scope definition, scheduling, cost estimation, and risk management.

CO3-Apply software effort estimation and evaluation techniques for effective project costing and planning.

CO4-Develop project schedules using activity sequencing, network planning models, and scheduling techniques.

CO5-Use software project metrics for measurement, prediction, productivity analysis, and performance monitoring.

CO6-Analyze the impact of globalization and Internet technologies on modern software project management practices.

CO7 –Manage project changes through configuration management and change control processes.

Unit	Title and Contents	No. of lectures
1.	**SOFTWARE PROJECT MANAGEMENT CONCEPTS** 1.1 Introduction to Software Project Management: Project phase and project life Cycle, Organizational structure. 1.2 An Overview of Project Planning: Select, Identifying Project scope and objectives, infrastructure, project products and characteristics, estimate efforts, identify activity risks, and allocate resources- TQM, Six Sigma 1.3 Software Quality: defining software quality, ISO9126, External Standards. 1.4 Project Plan development and Execution, Change control, Configuration Management, Activity Planning, Schedule Development and Control.	**06**
2.	**OVERVIEW OF PROJECT MANAGEMENT COMPONENTS** 2.1 Project Integration Management 2.2 Project Scope Management 2.3 Project Time Management 2.4 Project Cost Management 2.5 Project Quality Management 2.6 Project Human Resource Management 2.7 Project Communications Management 2.8 Project Risk Management 2.9 Project Procurement Management 3.0 Project Stakeholder Management	**06**
3.	**SOFTWARE EVALUATION AND COSTING** 3.1 Project Evaluation: Strategic Assessment, Technical 3.2. Assessment, cost-benefit analysis, flow forecasting, cost 3.3. Benefit evaluation techniques, Risk Evaluation. 3.4. Selection of Appropriate Project approach: Choosing 3.5. Technologies, choice of process models, structured methods. 3.6. Software Effort Estimation: Problems with Over and under estimations, Basis of software Estimation, Software estimation	**10**

	techniques, expert Judgment, Estimating by analogy. 3.7. Activity Planning: Project schedules, projects and activities, sequencing and scheduling Activities, networks planning models, Formulating a network model	
4.	**INTRODUCTION TO SOFTWARE PROJECT METRICS** 4.1. Introduction to Software Project Metrics, Types of Software Project Metrics, Scope of Software Project Metrics, Software metrics and Data collection. 4.2. Metrics Measurement: Measurement and prediction, Resource measurement, Productivity Measurement, Mapping measurement activities, Measurement tool, Role of Measures (Analyst, tools, Plans, Revision Plans) 4.3. Quality Measurement- Quality Standards (ISO, MC-Call, CMM, PSP/TSP) 4.4. Globalization issues in project management (Evaluation, Advantages, Dis-advantages) 4.5. Impact of the internet on project management (effect on management activities)	**08**

Reference Books:

- Bob Hughes & Mike Cotterell, "Software Project Management", Tata McGraw- Hill Publications, Fifth Edition 2012 .
- Futrell , "Quality Software Project Management", Pearson Education India, 2008.
- Gobalswamy Ramesh, "Managing Global Software Projects", Tata McGraw Hill Publishing Company, 2003.
- Richard H. Thayer "Software Engineering Project Management", IEEE Computer Society
- S. A. Kelkar, "Software Project Management" PHI, New Delhi, Third Edition ,2013
- Pressman, Roger S., & Maxim, B.R., "Software Engineering: A Practitioner's approach", 9th Edition, McGraw-Hill Education.
- http://en.wikipedia.org/wiki/Comparison_of_project_management_software
- http://www.ogc.gov.uk/methods_prince_2.asp

Mapping of this course with Programme Outcomes

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

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

Justification of PO1 to ALL COs:

PO1: Strong alignment as advanced project planning, estimation, scheduling, and metrics (CO1–CO5) require comprehensive disciplinary knowledge.

PO2: Closely related because hypothesis-based estimation, risk analysis, scheduling models, and change management (CO2–CO5, CO7) involve research and handling complexity.

PO3: Strong connection since applying project planning, costing, scheduling, globalization, and change control (CO2–CO7) supports real-world problem solving.

PO4: Strongly mapped as technical tools, estimation techniques, scheduling models, metrics, and configuration management (CO2–CO5, CO7) demand scientific reasoning and mastery.

PO5: Well aligned because project documentation, reporting metrics, globalization impact, and change communication (CO2, CO5–CO7) require clear stakeholder communication.

PO6: Moderately aligned as globalization practices and configuration management (CO6–CO7) involve ethical responsibility and professional judgment.

PO7: Strong linkage since modern tools, estimation methods, metrics, and evolving technologies (CO2–CO6) promote autonomous and lifelong learning.

PO8: Strongly related because project planning, estimation, metrics, globalization, and change management (CO2–CO7) enhance employability and innovation skills.

SYLLABUS (CBCS-2026 Pattern as per NEP 2020) FOR M. Sc. (Computer Science)

(w.e.f. A.Y. 2026-27)

Name of the Programme	:	M.Sc. Computer Science
Program Code	:	PSCOS
Class	:	M.Sc. (Computer Science)
Semester	:	I
Course Type	:	Major Mandatory
Course Name	**:**	**Front End Stack (MEAN) Practical**
Course Code	:	COS-504-MRM
No. of Lectures	:	60 hours (15 Practical's)
No. of Credits	:	02

Course Objectives:

1. **Understand Web Development Fundamentals**
   Gain a solid foundation in HTML, CSS, JavaScript, and modern web architecture.
2. **Master TypeScript for Scalable Applications**
   Learn TypeScript essentials to build type-safe, maintainable, and enterprise-ready applications.
3. **Develop Frontend Applications with Angular**
   Acquire skills in Angular components, routing, forms, services, and state management.
4. **Build Backend Services with Node.js & Express.js**
   Understand server-side programming, RESTful API design, authentication, and middleware.
5. **Develop Angular applications** with advanced features like RxJS, NgRx, and Angular Material.
6. **Integrate Fullstack Applications and Deploy to Cloud**
   Combine frontend and backend into complete MEAN applications and deploy them securely on cloud platforms.
7. **Explore Advanced Topics and Industry Practices**
   Gain exposure to microservices, real-time applications, DevOps basics, and project-based learning.

Course Outcomes:

CO1 : Apply core web technologies to design responsive, interactive user interfaces.

CO2 : Use TypeScript effectively to enhance code reliability and maintainability in both frontend and backend projects.

CO3 : Develop Angular applications with advanced features like RxJS, NgRx, and Angular Material.

CO4 : Implement secure and scalable APIs using Node.js and Express.js.

CO5 : Develop Angular applications with advanced features like RxJS, NgRx, and Angular Material.

CO6 : Deploy MEAN applications on cloud platforms with proper testing, CI/CD, and security practices.

CO7 : Demonstrate industry readiness by building and presenting a capstone project that integrates all MEAN stack components.

Ass. No.	Assignment Details
Assignment 1	**Web Development Fundamentals (Assignments 01–03)** Program 1: Create a responsive webpage using HTML5 & CSS3. Program 2: Build a simple JavaScript program to validate a login form.
Assignment 2	Program 1: Implement a JavaScript program to manipulate DOM elements (e.g., show/hide content). Program 2: Create a JSON-based student record and display it dynamically.
Assignment 3	Program 1: Develop a small REST API mock using JSON data. Program 2: Build a JavaScript program to fetch and display API data.
Assignment 4	**TypeScript Essentials (Assignments 04–06)** Program 1: Write a TypeScript program using basic types and interfaces. Program 2: Create a class in TypeScript with inheritance and methods.
Assignment 5	Program 1: Implement a TypeScript program using enums and generics. Program 2: Build a module-based TypeScript program with imports/exports.
Assignment 6	Program 1: Demonstrate decorators in TypeScript with a logging example. Program 2: Write a TypeScript program to handle asynchronous operations (Promises/async-await).
Assignment 7	**Angular Framework – Core Concepts (Assignments 07–10)** Program 1: Create a basic Angular app with components and data binding. Program 2: Build a directive to highlight text dynamically.
Assignment 8	Program 1: Implement Angular forms (template-driven). Program 2: Create a reactive form with validation.
Assignment 9	Program 1: Develop Angular routing with multiple pages. Program 2: Build a service for sharing data between components.
Assignment 10	Program 1: Use Angular pipes to format data (currency, date). Program 2: Create a custom pipe for string manipulation.
Assignment 11	**Angular – Advanced Features (Assignments 11–15)** Program 1: Fetch data from a REST API using Angular HTTP Client. Program 2: Display fetched data in a table with sorting.
Assignment 12	Program 1: Implement Observables with RxJS for live data updates. Program 2: Create a simple Angular app using Subject for communication.
Assignment 13	Program 1: Integrate Angular Material components (buttons, cards). Program 2: Build a responsive navigation bar with Angular Material.
Assignment 14	Program 1: Implement NgRx for state management in a small app. Program 2: Demonstrate CRUD operations with NgRx store.
Assignment 15	Program 1: Write unit tests for Angular components using Jasmine/Karma. Program 2: Test Angular services with mock data.

Reference Books:

- Node.js , MongoDb and Angular Web Development – Brad Dayley , Brendan Dayley , Caleb Dayley
- Web development with Node and Express – Ethan Brown , O-Reilly

Mapping of this course with Programme Outcomes

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

One-Line Justification (PO-wise)

PO1 – Advanced Disciplinary Knowledge
Strongly aligned as all COs build advanced, specialized MEAN stack expertise beyond foundational web development, particularly through full-stack integration and capstone development.

PO2 – Research, Analysis & Complexity
Closely connected since backend API design, database optimization, state management, and deployment require analytical thinking and handling complex system integration.

PO3 – Problem Solving in New Contexts
Strongly supported through real-world application development, cloud deployment, and full-stack problem-solving in dynamic, industry-relevant environments.

PO4 – Technical Mastery & Scientific Reasoning
Directly achieved as students use modern frameworks, tools, DevOps practices, and architecture decisions with methodological reasoning.

PO5 – Integrated Communication
Moderately supported through UI design, API documentation, and capstone presentation, where students communicate technical outcomes clearly.

PO6 – Ethical, Social & Professional Judgment
Moderate to strong alignment via secure API development, cloud security practices, professional coding standards, and responsible deployment.

PO7 – Autonomous & Lifelong Learning
Strongly linked since mastering evolving technologies like Angular, Node.js, MongoDB, and DevOps requires continuous self-learning and adaptation.

PO8 – Employability, Innovation & Entrepreneurship
Very strongly aligned as the course builds complete industry-ready MEAN stack skills culminating in a deployable capstone project.

SYLLABUS (CBCS-2026 Pattern as per NEP 2020) FOR M. Sc. (Computer Science)
(w. e. f A.Y 2026-27)

Name of the Programme	: M.Sc. Computer Science
Program Code	: PSCOS
Class	: M.Sc. (Computer Science)
Semester	: I
Course Type	: Major Mandatory (Practical)
Course Name	: Database Technologies
Course Code	: COS-505-MRM
No. of Practicals	:15 Practical's
No. of Credits	: 02

Prerequisites: Knowledge of RDBMS

Course Objectives:

1. Students will gain knowledge about unstructured database and its importance
2. Students will understand the structure of MongoDB and various operations of it.
3. Students will study and analyze the difference between structured and unstructured database.
4. Students will study aggregation operations in MongoDB
5. Students will understand the front-end connectivity with MongoDB.
6. Students will gain knowledge about index and its importance in queries.

Course Outcomes:

CO1 - Explain core database concepts such as data models, DBMS architecture, schemas, and data independence.
CO2 - Create conceptual and logical database designs using ER models and convert them into relational schemas.
CO3 -Analyse and normalize database tables (1NF, 2NF, 3NF, BCNF) to eliminate redundancy and ensure data integrity.
CO4 Construct and execute SQL queries (DDL, DML, DCL, TCL) to create, manipulate, and manage databases.
CO5 - Enforce primary keys, foreign keys, unique constraints, and validation rules to maintain data consistency.
CO6 - Demonstrate understanding of ACID properties, transaction management, locking mechanisms, and concurrency control.
CO7 – Perform basic database administration tasks such as backup, recovery, indexing, security management, and performance optimization.

Reference Books:

- Murach's MySQL by Joel Murach /Shroff Publisher
- Database System Concepts by Abraham Silberschatz, Henry Korth and S. Sudarshan / McGraw Hill
- Database Design and Relational Theory: Normal Forms and All That Jazz by C. J. Date / O'Reilly
- Fundamentals of Database System by Shamkant B. Navathe, RamezElmasri / Pearson
- MongoDB:The Definitive Guide by Shannon Bradshaw, Eoin Brazil and Kristina Chodorow / O'Reilly

Assignment No	Name of the Assignment	No of Practical
1	Exploring MySQL Monitor, Shell, and Workbench Tools	1
2	Implementing CREATE, ALTER, and DROP Commands	1
3	Performing DML Operations (INSERT, UPDATE, DELETE) and TRUNCATE	1
4	Defining and Modifying Column Data Types	1
5	Creating, Altering, and Dropping Constraints	1
6	Using Aggregate Functions with GROUP BY and HAVING Clause	1
7	Implementing Union and Union all Operations	1
8	Working with Subqueries and Correlated Queries	1
9	Managing Transactions Using COMMIT, ROLLBACK, and SAVEPOINT	1
10	Assignment on Views	1
11	Assignment on Developing Stored Procedures	1
12	Assignment on Function with Parameters	1
13	Assignment on Cursor	1
14	Assignment on Trigger	1
15	Assignment on Exception Handling	1

Mapping of this course with Programme Outcomes

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

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

Justification:

PO1 – Advanced Disciplinary Knowledge & Originality:
CO1, CO2, CO3, and CO6 build strong foundational and advanced database knowledge enabling originality in database system design.

PO2 – Research, Analysis, and Complexity:
CO2, CO3, and CO6 enhance analytical thinking and the ability to handle complex database design and transaction problems.

PO3 – Problem Solving in New Contexts:
CO4, CO6, and CO7 develop the ability to solve real-world database implementation and administration challenges.

PO4 – Technical Mastery and Scientific Reasoning:
All COs strongly contribute by developing technical competence in database design, querying, optimization, and management.

PO5 – Integrated Communication:
CO2, CO4, and CO7 support structured documentation, query formulation, and technical communication in database environments.

PO6 – Ethical, Social, and Professional Judgment:
CO5, CO6, and CO7 promote responsible data handling, security enforcement, and professional database management practices.

PO7 – Autonomous and Lifelong Learning:
CO6 and CO7 encourage continuous learning in evolving database technologies and system administration practices.

PO8 – Employability, Innovation, and Entrepreneurship:
CO4 and CO7 enhance industry readiness, practical skills, and the ability to build and manage database-driven applications.

SYLLABUS (CBCS-2026 Pattern as per NEP 2020) FOR M. Sc. (Computer Science)

(w. e. f A.Y 2026-27)

Name of the Programme	: M.Sc. Computer Science
Program Code	: PSCOS
Class	: M.Sc. (Computer Science)
Semester	: I
Course Type	: Major Elective (TH)
Course Name	: Basic DotNet
Course Code	:COS-506-MJE(A)
No. of Lectures	:30 Hours
No. of Credits	: 02

Prerequisites:

1. Basic knowledge of computer fundamentals, including operating systems and file management.
2. Understanding of programming fundamentals, such as variables, data types, operators, and control structures (preferably in C or C++).
3. Basic concepts of Object-Oriented Programming (OOP) including classes, objects, inheritance, and polymorphism.
4. Familiarity with database fundamentals, including tables, basic SQL queries, and relational concepts.

Course Objectives:

1. Able to understand the DOTNET framework
2. C# language features and Windows application development using C#.Net
3. C# is used to understand, diagram, and implement programming concepts.
4. C# decision structures use iteration, class methods, fields, and properties to find logistical alternatives.
5. Creating Desktop Applications using.Net Controls
6. Able to understand the Entity framework
7. Use of Entity Framework in the programming environment

Course Outcomes:

CO1 - Ability to write the Visualized programming and design different real-life problems

CO2 - Explain the three pillars of object-oriented programming.

CO3 -Develop working knowledge of C# programming constructs and the .NET Framework.

CO4 - Write an object-oriented program using custom classes.

CO5 - Build and debug well-formed Web Forms with ASP.

CO6 - Perform form validation with validation controls.

CO7 -Create simple data binding applications. Mapping this Course Outcomes with Programme Outcomes.

Unit	Title and Contents	No. of lectures
1.	**.NET Framework and C# Fundamentals** 1 **Introduction to .NET Framework** 1.1 Introduction to .NET 1.2 .NET Class Framework 1.3 Common Language Runtime (CLR) • Overview • Elements of .NET Application • Memory Management • Garbage Collector: Faster Memory Allocation, Optimizations 1.4 Common Language Integration • Common Type System (CTS) • Reflection API 1.5 User and Program Interface 2**. Introduction to C#** 2.1 Language Features • Variables and Expressions, Type Conversion • Flow Control • Functions and Delegates • Debugging and Error Handling • Exception Handling (System Defined and User Defined)	8
2.	**Object-Oriented Programming and Advanced C# Concepts** 1. **Object Oriented Concepts** • Defining Classes and Class Members • Interfaces and Properties • Access Modifiers • Implementation of Class, Interface, and Properties • Hiding Base Class Methods • Method Overriding • Event Handling **2. Collections, Comparisons and Conversions** • Defining and Using Collections • Indexers and Iterators • Type Comparison and Value Comparison • Overloading Conversion Operators • as Operator **3. Generics** • Using Generics • Defining Generics	8

	• Generic Interfaces • Generic Methods • Generic Delegates	
3.	**Windows Programming, Data Handling and Reporting** 1. **Windows Programming** • Window Controls o Common Controls o Container Controls o Menus and Toolbars o Printing o Dialogs o Data Tools • Deploying Windows Applications o Deployment Overview o Adding Setup Project o Building the Project and Installation **2. Data Handling** • File System Data • XML Data • Databases and ADO.NET **3. Reporting Tools** • Data Report • Crystal Report **4. .NET Assemblies** • Components • .NET Assembly Features • Structure of Assemblies • Calling Assemblies • Private and Shared Assemblies	7
4.	**ASP.NET and Web Technologies** 1. **Introduction to ASP.NET** • History of Web Programming • Basics of Web Programming **2. Server Controls, Variables and Functions** • Forms, Web Pages, HTML Forms, Web Forms • Request and Response in Non-ASP.NET Pages • ASP.NET Server Controls • Data Types: Numeric, Text, Arrays, Data Collections • Control Structures **3. Event Driven Programming and PostBack**	7

	• HTML Events • ASP.NET Page Events • ASP.NET Web Control Events • Event Driven Programming and PostBack **4. Database Access and State Management** • Data Pages • ADO.NET • Cookies and Sessions • Session Events • State Management Recommendations **5. Web Services** • HTTP, XML and Web Services • SOAP • Building ASP.NET Web Services • Consuming Web Services	

Reference Books:

1. Beginning Visual C#, Wrox Publication
2. Professional Visual C#, Wrox Publication
3. Inside C#, by Tom Archer ISBN: 0735612889 Microsoft Press Â© 2001, 403 pages
4. Beginning ASP.NET 3.5, Wrox Publication
5. Programming ASP.NET 3.5 by Jesse Liberty, Dan Maharry, Dan Hurwitz, O'Reilly
6. Illustrated C# 2008, Solis, Publication APRESS, ISBN 978-81-8128-958-2
7. Professional C# 4.0 and .NET 4by Christian Nagel, Bill Evjen, Jay Glynn, Karli Watson, 8. Morgan Skinner, WROX
9. Beginning C# Object-Oriented Programming By Dan Clark ,Apress
10. ADO.NET Examples and Best Practices for C# Programmers, By Peter D. Blackburn
11. Database Programming with C#, By Carsten Thomsen, Apress

Mapping of this course with Programme Outcomes

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

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

One-Line Justification for Each PO:

1. **PO1:** CO2, CO3, and CO4 strengthen advanced disciplinary knowledge through object-oriented concepts and .NET programming foundations.
2. **PO2:** CO1 and CO4 promote analytical thinking and problem formulation by designing and implementing solutions to real-life problems.
3. **PO3:** CO1, CO4, and CO5 emphasize applying programming knowledge to unfamiliar and real-world web-based problem domains.
4. **PO4:** CO3 to CO7 strongly support technical mastery through hands-on use of C#, ASP.NET, validation, and data binding tools.
5. **PO5:** CO5 and CO7 enable effective communication of application logic and results through structured web interfaces.
6. **PO6:** CO6 and CO4 address professional responsibility by enforcing correct input handling, validation, and reliable software practices.
7. **PO7:** CO3 and CO4 encourage self-directed learning by developing independent programming and debugging skills.
8. **PO8:** CO1, CO3, CO4, CO5, and CO7 collectively enhance employability and innovation via industry-relevant application development skills.

SYLLABUS (CBCS-2026 Pattern as per NEP 2020) FOR M. Sc. (Computer Science)

(w. e. f A.Y 2026-27)

Name of the Programme	: M.Sc. Computer Science
Program Code	: PSCOS
Class	: M.Sc. (Computer Science)
Semester	: I
Course Type	: Major Elective (TH)
Course Name	: Cloud Computing
Course Code	: COS-506-MJE(B)
No. of Lectures	: 30 Hours
No. of Credits	: 02

Prerequisites:

1. Basic knowledge of computer fundamentals, including operating systems, computer networks, and file systems.
2. Understanding of programming concepts, such as variables, data types, control structures, and functions (preferably in C/C++/Java/Python).
3. Basic concepts of data structures, including arrays, lists, and trees.
4. Fundamental understanding of computer networks, including TCP/IP, client–server architecture, and Internet concepts.
5. Basic knowledge of operating system concepts, such as processes, threads, memory management, and scheduling.

Course Objectives:

1. Understand the fundamental concepts, models, and enabling technologies of distributed and cloud computing systems.
2. Explain scalable computing techniques over the Internet with respect to performance, security, and energy efficiency.
3. Study virtualization concepts, implementation levels, and mechanisms used in clusters and data centers.
4. Analyze cloud platform architectures built over virtualized data centers and interconnection networks.
5. Compare cloud service models and major public cloud platforms such as Google App Engine, AWS, and Microsoft Azure.
6. Understand cloud security challenges, risks, trust management, and protection mechanisms for data, software, and infrastructure.
7. Learn cloud programming models and software environments for parallel and distributed applications.

Course Outcomes:

CO1 - Explain distributed system models, cloud computing concepts, and enabling technologies.

CO2 - Analyze performance, security, and energy efficiency issues in distributed cloud systems.

CO3 -Describe virtualization techniques for CPU, memory, I/O devices, clusters, and data centers.

CO4 - Evaluate cloud platform architecture and resource management strategies over

virtualized data centres.

CO5 -Compare public cloud platforms and cloud service models for different application requirements.

CO6 - Identify cloud security threats and apply appropriate security, privacy, and trust management techniques.

CO7 -Develop and deploy basic cloud-based applications using cloud programming environments and platforms.

Unit	Title and Contents	No. of lectures
1.	**Distributed System Models and Enabling Technologies** 1.1 Scalable Computing over the Internet 1.2 Technologies for Network-Based Systems 1.3 System Models for Distributed and Cloud Computing 1.4 Software Environments for Distributed Systems and Clouds 1.5 Performance Issues in Distributed and Cloud Systems 1.6 Security and Energy Efficiency in Cloud Computing	8
2.	**Virtualization and Data Center Technologies** 2.1 Virtual Machines and Virtualization Concepts 2.2 Implementation Levels of Virtualization 2.3 Virtualization Structures, Tools, and Mechanisms 2.4 Virtualization of CPU, Memory, and I/O Devices 2.5 Virtual Clusters and Resource Management 2.6 Virtualization for Data Center Automation	7
3.	**Cloud Platform Architecture and Public Clouds** 3.1 Cloud Computing Concepts and Service Models 3.2 Data Center Design and Interconnection Networks 3.3 Architectural Design of Compute Clouds 3.4 Architectural Design of Storage Clouds 3.5 Public Cloud Platforms: Google App Engine, Amazon Web Services, and Microsoft Azure 3.6 Inter-Cloud Resource Management	7
4.	**Cloud Security, Trust Management, and Programming Environments** **4.1 Cloud Security** • Security as a Top Concern for Cloud Users • Cloud Security Risks and Privacy Impact Assessment • Cloud Data Encryption Techniques • Security of Database Services • Operating System and Virtual Machine Security • Security Risks from Shared Images and Management OS	8

	• XOAR and Trusted Hypervisors • Mobile Devices and Cloud Security **4.2 Cloud Security and Trust Management** • Cloud Security Defense Strategies • Distributed Intrusion and Anomaly Detection • Data and Software Protection Techniques • Reputation-Guided Protection of Data Centers **4.3 Cloud Programming and Software Environments** • Features of Cloud and Grid Platforms • Parallel and Distributed Computing Paradigms • Programming Support for Google App Engine • Programming on Amazon AWS and Microsoft Platforms • Emerging Cloud Software Environments	

Reference Books:

1. Distributed Systems: Concepts and Design, Pearson Education
2. Cloud Computing: Principles and Paradigms, Wiley India
3. Mastering Cloud Computing, McGraw Hill Education
4. Cloud Security and Privacy, O'Reilly Media
5. Virtualization Essentials, Wiley Publishing
6. Programming Distributed Computing Systems, McGraw Hill Education
7. Beginning Cloud Computing, Apress

Mapping of this course with Programme Outcomes

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

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

One-Line Justification for Each PO

- PO1: CO1, CO3, and CO4 strongly support advanced disciplinary knowledge through in-depth understanding of distributed systems, virtualization, and cloud architectures.
- PO2: CO2, CO4, and CO6 emphasize research and analytical skills by addressing performance evaluation, resource management, and cloud security challenges.
- PO3: CO2, CO5, CO6, and CO7 enable problem-solving in new and real-world contexts through platform comparison, security mitigation, and cloud application

deployment.

- PO4: All COs strongly contribute by developing technical mastery of cloud concepts, virtualization techniques, architectural evaluation, and practical implementation.
- PO5: CO5 and CO7 support effective communication by enabling comparison of cloud service models and demonstration of cloud-based applications.
- PO6: CO6 strongly addresses ethical and professional judgment through identification of security threats and application of privacy, trust, and compliance mechanisms.
- PO7: CO3, CO4, and CO7 promote autonomous and lifelong learning by encouraging independent exploration of virtualization, cloud resource strategies, and deployment tools.
- PO8: All COs strongly enhance employability and innovation by building industry-relevant skills in cloud platforms, security, performance optimization, and application development.

SYLLABUS (CBCS-2026 Pattern as per NEP2020) FOR M.Sc. (ComputerScience)

(w. e. f. A.Y 2026-27)

Name of the Programme	:M.Sc.(Computer Science)
Program Code	: PSCOS
Class	:M.Sc.(Computer Science)
Semester	: I
Course Type	: Major Elective (PR)
Course Name	: Lab Course on Basic Dot Net
Course Code	: COS-507-MJE(A)
No. of Lectures	: 60 Hours (15Practical)
No. of Credits	: 02Credits

Prerequisites:

1. Basic knowledge of programming fundamentals, including variables, data types, operators, and control flow statements.
2. Understanding of Object-Oriented Programming concepts, such as classes, objects, inheritance, polymorphism, and interfaces.
3. Basic familiarity with C# language syntax and simple console-based application development.
4. Introductory knowledge of .NET Framework, including CLR and basic project structure in Visual Studio.
5. Basic understanding of Windows operating environment and use of an Integrated Development Environment (IDE).

Course Objectives:

1. Able to understand the DOTNET framework
2. C# language features and Windows application development using C#.Net
3. C# is used to understand, diagram, and implement programming concepts.
4. C# decision structures use iteration, class methods, fields, and properties to find logistical alternatives.
5. Creating Desktop Applications using.Net Controls
6. Able to understand the Entity framework
7. Use of Entity Framework in the programming environment

Course Outcomes:

CO1-Understand the Microsoft.NET Framework and C#.NET structure
CO2- Design application with variety of controls
CO3-Access the data using in-built data access tools.
CO4-Use Microsoft ADO.NET to access data in Application
CO5- Configure and deploy C# Application
CO6- Develop secured C# application
CO7-Identify and resolve problems(debug/troubleshoot) in C#.NET window- based application

Unit	Title and Contents	No. of lectures
Assignment 1	Parameter Modifiers (ref, out, params)	4 Hr
Assignment 2	Delegate and Events	4 Hr
Assignment 3	Inheritance and Interface	4 Hr
Assignment 4	Polymorphism (Method Overloading, Operator Over loading and Method Overriding	4 Hr
Assignment 5	Exception Handling	4 Hr
Assignment 6	Collections	4 Hr
Assignment 7	Generics	4 Hr
Assignment 8	Use of Basics Form Controls	4 Hr
Assignment 9	Use of Dialogue Boxes	4 Hr
Assignment 10	Simple Database Operations	4 Hr
Assignment 11	Advanced Database Operations	4 Hr
Assignment 12	Simple Crystal Report	4 Hr
Assignment 13	Advanced Crystal Report	4 Hr
Assignment 14	Event Handling (Calculator)	4 Hr
Assignment 15	Entity Framework	4 Hr

Reference Books:

1. Beginning Visual C#, Wrox Publication
2. Professional Visual C#, Wrox Publication
3. Database Programming with C#, By Carsten Thomsen, A press
4. Beginning C# Object-Oriented Programming by Dan Clark, A press
5. Beginning C# Object-Oriented Programming by Dan Clark, A press

Mapping of this course with Programme Outcomes

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

Weight:1-Partiallyrelated 2-ModeratelyRelated 3-Strongly related

One-Line Justification for Each PO

- **PO1:** CO1 and CO4 strongly support advanced disciplinary knowledge through in-depth understanding of .NET architecture and ADO.NET–based application development.
- **PO2:** CO3, CO4, and CO7 emphasize analytical skills by enabling data handling,

structured access, and systematic debugging of complex applications.

- **PO3:** CO2, CO6, and CO7 foster problem-solving abilities in new contexts through secure application design and troubleshooting real-world issues.
- **PO4:** All COs strongly contribute by ensuring hands-on mastery of modern tools, frameworks, deployment, security, and debugging with sound technical reasoning.
- **PO5:** CO5 moderately supports communication by enabling deployment and presentation of functional applications to diverse stakeholders.
- **PO6:** CO6 strongly addresses ethical and professional responsibility by focusing on secure application development and responsible data handling.
- **PO7:** CO3, CO4, and CO7 promote self-directed and lifelong learning through independent problem identification, experimentation, and resolution.
- **PO8:** All COs strongly enhance employability and innovation by developing industry-relevant skills in application design, data access, security, deployment, and maintenance.

SYLLABUS (CBCS-2026 Pattern as per NEP 2020) FOR M. Sc. (Computer Science)

(w. e. f A.Y 2026-27)

Name of the Programme	: M.Sc. Computer Science
Program Code	: PSCOS
Class	: M.Sc. (Computer Science)
Semester	: I
Course Type	: Major Elective (PR)
Course Name	: Lab Course onCloud Computing
Course Code	: COS-507-MJE(B)
No. of Lectures	: 60 Hours (15Practical)
No. of Credits	: 02

Prerequisites:

1. Basic understanding of computer networks, including Internet concepts, IP addressing, and client–server architecture.
2. Fundamental knowledge of operating systems, such as processes, virtual machines, and file systems.
3. Basic programming skills in any one language (Python / Java / C#), including variables, functions, and control structures.
4. Introductory knowledge of databases, including relational concepts and basic SQL queries.
5. Basic understanding of web technologies, such as HTTP, REST APIs, and web applications.

Course Objectives:

1. Understand the fundamentals of cloud computing platforms and services using hands-on cloud environments.
2. Learn to configure, deploy, and manage virtual machines and cloud resources using command-line and web-based tools.
3. Gain practical experience with cloud storage, databases, messaging, and monitoring services.
4. Understand serverless computing concepts and implement event-driven cloud applications.
5. Learn containerization and orchestration concepts using Docker and Kubernetes.
6. Explore cloud networking, caching, security, and performance optimization techniques.
7. Develop skills for automating application deployment using CI/CD pipelines and cloud DevOps tools.

Course Outcomes:

CO1 - Create and manage cloud infrastructure components such as virtual machines, storage, and networks.

CO2 - Use cloud shell and command-line tools to provision, monitor, and control cloud resources.

CO3 -Develop and deploy serverless functions and RESTful APIs for cloud-based applications.

CO4 - Implement cloud storage, database, and messaging services for scalable and reliable applications.
CO5 -Containerize applications and deploy them on managed Kubernetes clusters.
CO6 - Apply caching, monitoring, and security mechanisms to improve application performance and reliability.
CO7 -Automate application build, test, and deployment processes using CI/CD pipelines in cloud environments.

Unit	Title and Contents	No. of lectures
Assignment 1	Creating a Virtual Machine: Configure and deploy a virtual machine with specific CPU and memory requirements in Google Cloud. **OR** Exploring AWS Cloud Shell and the AWS Cloud9 IDE	4 Hr
Assignment 2	Getting Started with Cloud Shell and gcloud: Discover the use of gcloud commands to manage Google Cloud resources from Cloud Shell. **OR** Working with Amazon S3Orchestrating Serverless Functions with AWS Step Functions	4 Hr
Assignment 3	Cloud Functions: Create and deploy a Cloud Function to automate a specific task based on a Cloud Storage event. **OR** Working with Amazon DynamoDB	4 Hr
Assignment 4	App Engine: Deploy a web application on App Engine with automatic scaling enabled. **OR** Developing REST APIs with Amazon API Gateway	4 Hr
Assignment 5	Cloud Storage: Qwikstart: Google Cloud Storage provides scalable and secure object storage for managing data, accessible via the Cloud Console or gsutil CLI. **OR** Creating Lambda Functions Using the AWS SDK for Python	4 Hr
Assignment 6	Cloud SQL for MySQL: Discover how Google Cloud SQL for MySQL provide automated management and high availability for MySQL databases?	4 Hr
Assignment 7	Cloud Pub/Sub: Experiment how Google Cloud Pub/Sub facilitate real-time messaging and communication between distributed applications.	4 Hr
Assignment 8	Multiple VPC Networks: Explore benefits of using multiple VPC networks in Google Cloud for organizing and isolating resources.	4 Hr
Assignment 9	Cloud Monitoring: Discover how Cloud Monitoring help in tracking and analyzing the performance and health of cloud resources?	4 Hr

Assignment 10	Kubernetes Engine: Qwik Start: Deploy a containerized application to a Kubernetes Engine cluster.	4 Hr
Assignment 11	Migrating a Web Application to Docker Containers	4 Hr
Assignment 12	Caching Application Data with ElastiCache, Caching with Amazon CloudFronT, Caching Strategies	4 Hr
Assignment 13	Implementing CloudFront for Caching and Application Security	4 Hr
Assignment 14	Orchestrating Serverless Functions with AWS Step Functions	4 Hr
Assignment 15	Automating Application Deployment Using a CI/CD Pipeline	4 Hr

Reference Books:

1. Cloud Computing: Concepts, Technology & Architecture, Pearson Education
2. Cloud Computing: Principles and Paradigms, Wiley India
3. Mastering Cloud Computing, McGraw Hill Education
4. Architecting the Cloud, Wiley Publishing
5. Cloud Security and Privacy, O'Reilly Media
6. Docker Deep Dive, Packt Publishing
7. Kubernetes in Action, Manning Publications
8. AWS Certified Solutions Architect Official Study Guide, Wiley Publishing
9. Google Cloud Platform in Action, Manning Publications
10. DevOps and CI/CD Pipeline Automation, Packt Publishing

Mapping of this course with Programme Outcomes

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

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

One-Line Justification for Each PO

- **PO1:** CO1, CO3, CO4, and CO5 strongly contribute to advanced disciplinary knowledge through hands-on design and management of modern cloud infrastructures and platforms.
- **PO2:** CO2, CO3, CO6, and CO7 emphasize analytical and research skills by enabling monitoring, optimization, security analysis, and automation in complex cloud environments.
- **PO3:** CO1, CO3, CO4, CO5, CO6, and CO7 support problem solving in new contexts through real-world cloud deployment, scalability, and reliability challenges.
- **PO4:** All COs strongly support technical mastery by providing practical exposure to cloud tools, containerization, orchestration, automation, and performance optimization.
- **PO5:** CO3 and CO7 facilitate integrated communication by enabling deployment, documentation, and demonstration of cloud-based services and CI/CD workflows.
- **PO6:** CO6 strongly addresses ethical and professional judgment by incorporating security, monitoring, and responsible resource usage in cloud applications.
- **PO7:** CO2, CO3, CO5, and CO7 encourage autonomous and lifelong learning through self-directed exploration of cloud tools, DevOps practices, and automation pipelines.
- **PO8:** All COs strongly enhance employability, innovation, and entrepreneurship by aligning with industry-standard cloud, DevOps, and container orchestration practices.

SYLLABUS (CBCS-2026 as per NEP 2020) FOR M. Sc. (Computer Science)-I
SEM-I

(w. e. from June, 2026)

Name of the Programme : M.Sc. Computer Science
Program Code : PSCOS
Class : M.Sc. (Computer Science)
Semester : I
Course Type : RM
Course Name : Research Methodology (Theory)
Course Code : COS-508-RM
No. of Lectures : 60
No. of Credits : 4

A) Course Objectives:

1. Identify and discuss the role and importance of research in the social sciences.
2. Identify and discuss the issues and concepts salient to the research process.
3. Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.
4. Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.
5. Students should be able to distinguish between the writing structure used for a quantitative study and one used for a qualitative study
6. Develop skills in qualitative and quantitative data analysis and presentation
7. Develop advanced critical thinking skills

B) Course Outcomes:

CO1: Equip themselves with ethical issues related to Research and Publication.
CO2: Build a strong foundation for future research work in a systematic manner by applying notions of Research Methodology.
CO3: Gain ability to apply knowledge of Computer Science to research in real-world issues.
CO4: Get familiar with current research trends in various core areas of Computer Science.
CO5: Know the knowledge, general competence, and analytical skills in Research Methodology and Research & Publication Ethics.
CO6: Build their foundation for research in Computer Science.
CO7: Provide hands-on experience to carry out research work in Computer Science as well as interdisciplinary areas.

Unit No.	Title & Contents	No. of Lectures
Unit–I	**Foundations of Research** Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process	06
Unit–II	**Problem Identification & Formulation** Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance	06
Unit–III	**Research Design: Concept and Importance in Research** Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.	06
Unit–IV	**Qualitative and Quantitative Research** Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.	04
Unit -V	**Measurement** Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio	04
Unit VI	**Sampling** Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non-Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.	07
Unit VII	**Data Analysis** Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.	05
Unit - VIII	**Interpretation of Data and Paper Writing** Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.	06
Unit-IX	Use of Encyclopaedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.	04
Unit-X	Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism	06

Book References:

1. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by John W. Creswell
2. Research in Education by Best and Kahn
3. Research and methodology by C. R. Kothari
4. Understanding the research problem by Paul Oliver
5. Research Methods by Rashmi Agrawal
6. An Introduction to Qualitative Research by Uwe Flick

CO–PO Mapping Table

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	1	1	2	3	2	1
CO2	3	3	2	3	2	2	2	1
CO3	3	3	3	3	2	2	2	2
CO4	3	2	2	2	2	1	3	2
CO5	3	3	2	2	2	3	2	1
CO6	3	3	2	2	1	2	3	2
CO7	3	3	3	3	3	2	3	3

Justification

CO1: Ethical issues in Research & Publication

- **PO1 (2):** Enhances disciplinary understanding through awareness of ethical research practices.
- **PO2 (2):** Supports responsible hypothesis formulation and data handling.
- **PO3 (1):** Indirectly contributes to problem-solving through ethical decision-making.
- **PO4 (1):** Limited link to technical tool usage in ethical compliance.
- **PO5 (2):** Improves responsible scientific communication and publication clarity.
- **PO6 (3):** Strongly aligned with research ethics and professional responsibility.
- **PO7 (2):** Encourages self-regulated ethical learning practices.
- **PO8 (1):** Provides foundational ethical awareness for professional environments.

CO2: Apply Research Methodology Systematically

- **PO1 (3):** Builds advanced and structured disciplinary research knowledge.
- **PO2 (3):** Strongly supports hypothesis development and experimental design.
- **PO3 (2):** Enables application of structured methodology in new contexts.
- **PO4 (3):** Promotes appropriate selection and justification of research tools.
- **PO5 (2):** Enhances structured research reporting and documentation skills.
- **PO6 (2):** Encourages ethical conduct in systematic research practices.
- **PO7 (2):** Develops independent research planning skills.
- **PO8 (1):** Provides basic research competency useful in professional settings.

CO3: Apply CS Knowledge to Real-World Research Issues

- **PO1 (3):** Demonstrates advanced disciplinary expertise in applied research.
- **PO2 (3):** Requires analytical thinking and handling complex real-world data.
- **PO3 (3):** Strongly aligned with solving real-world and multidisciplinary problems.
- **PO4 (3):** Involves effective use of modern CS tools and techniques.

- **PO5 (2):** Requires communicating applied research findings clearly.
- **PO6 (2):** Considers societal and professional implications of solutions.
- **PO7 (2):** Encourages continuous skill upgrading in applied domains.
- **PO8 (2):** Enhances employability through real-world research competence.

CO4: Familiarity with Current Research Trends

- **PO1 (3):** Strengthens advanced and contemporary disciplinary knowledge.
- **PO2 (2):** Supports critical analysis of evolving research developments.
- **PO3 (2):** Enables adapting knowledge to emerging problem domains.
- **PO4 (2):** Encourages awareness of modern tools and evolving methodologies.
- **PO5 (2):** Promotes scholarly discussions on current advancements.
- **PO6 (1):** Limited but relevant awareness of ethical issues in emerging areas.
- **PO7 (3):** Strongly promotes lifelong and autonomous learning habits.
- **PO8 (2):** Improves innovation readiness and career adaptability.

CO5: Analytical Skills in Research Methodology & Ethics

- **PO1 (3):** Develops in-depth research-oriented disciplinary competence.
- **PO2 (3):** Strongly enhances analytical and evaluative research abilities.
- **PO3 (2):** Supports structured problem-solving in research scenarios.
- **PO4 (2):** Encourages justified methodological selection and reasoning.
- **PO5 (2):** Improves clarity in presenting analytical conclusions.
- **PO6 (3):** Strongly reinforces ethical reasoning and professional judgment.
- **PO7 (2):** Builds independent evaluative thinking skills.
- **PO8 (1):** Offers analytical competence useful in professional roles.

CO6: Foundation for Research in Computer Science

- **PO1 (3):** Provides advanced foundational disciplinary knowledge.
- **PO2 (3):** Establishes research design and analytical capabilities.
- **PO3 (2):** Supports application of foundational knowledge to new domains.
- **PO4 (2):** Encourages understanding of appropriate research tools.
- **PO5 (1):** Limited but relevant contribution to academic communication.
- **PO6 (2):** Promotes responsible research conduct awareness.
- **PO7 (3):** Strongly fosters independent and lifelong research learning.
- **PO8 (2):** Enhances research readiness for industry and academia.

CO7: Hands-on Research & Interdisciplinary Experience

- **PO1 (3):** Demonstrates advanced research proficiency in CS.
- **PO2 (3):** Strongly involves hypothesis testing and complex analysis.
- **PO3 (3):** Directly applies knowledge to unfamiliar and interdisciplinary contexts.
- **PO4 (3):** Requires mastery of tools, techniques, and scientific reasoning.
- **PO5 (3):** Strongly enhances presentation and publication skills.
- **PO6 (2):** Encourages ethical awareness in collaborative research settings.
- **PO7 (3):** Promotes autonomous research execution.
- **PO8 (3):** Strongly supports employability, innovation, and entrepreneurship.