Anekant Education Society's

Tuljaram Chaturchand College, Baramati

(Empowered Autonomous)

Four Year B. Sc. Degree Program in Computer Science

(Faculty of Science & Technology)

CBCS Syllabus

T. Y. B. Sc. (Computer Science) Semester – Vi

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 2025-2026

Title of the Programme: T. Y. B. Sc. (Computer Science)

Preamble

AES's Tuljaram Chaturchand College has made the decision to change the syllabus of 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 Sixth semester of T.Y.B.Sc.(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 Outcomes (POs)
for
B.Sc. (Computer Science)

PO1. Comprehensive Knowledge and Understanding: Graduates will possess a profound understanding of their field of study, including foundational theories, principles, methodologies, and key concepts, within a broader multidisciplinary context.

PO2. Practical, Professional, and Procedural Knowledge: Graduates will acquire practical skills and expertise essential for professional tasks within their field. This includes knowledge of industry standards, best practices, regulations, and ethical considerations, with the ability to apply this knowledge effectively in real-world scenarios.

PO3. Entrepreneurial Mindset and Knowledge: Graduates will cultivate an entrepreneurial mindset, identifying opportunities, fostering innovation, and understanding business principles, market dynamics, and risk management strategies.

PO4. Specialized Skills and Competencies: Graduates will demonstrate proficiency in technical skills, analytical abilities, problem-solving, effective communication, and leadership, relevant to their field of study. They will also adapt and innovate in response to changing circumstances.

PO5. Capacity for Application, Problem-Solving, and Analytical Reasoning: Graduates will possess the capacity to apply learned concepts in practical settings, solve complex problems, and analyze data effectively. This requires critical thinking, creativity, adaptability, and a readiness to learn and take calculated risks.

PO6. Communication Skills and Collaboration: Graduates will effectively communicate complex information, both orally and in writing, using appropriate media and language. They will also collaborate effectively in diverse teams, demonstrating leadership qualities and facilitating cooperative efforts toward common goals.

PO7. Research-related Skills: Graduates will demonstrate observational and inquiry skills, formulate research questions, and utilize appropriate methodologies for data collection and analysis. They will also adhere to research ethics and effectively report research findings.

PO8. Learning How to Learn Skills: Graduates will acquire new knowledge and skills through self-directed learning, adapt to changing demands, and set and achieve goals independently.

PO9. Digital and Technological Skills: Graduates will demonstrate proficiency in using ICT, accessing information sources, and analyzing data using appropriate software.

PO10. Multicultural Competence, Inclusive Spirit, and Empathy: Graduates will engage effectively in multicultural settings, respecting diverse perspectives, leading diverse teams, and demonstrating empathy and understanding of others' perspectives and emotions.

PO11. Value Inculcation and Environmental Awareness: Graduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and take appropriate actions to promote sustainability and environmental conservation.

PO12. Autonomy, Responsibility, and Accountability: Graduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts.

PO13. Community Engagement and Service: Graduates will actively participate in community-engaged services and activities, promoting societal well-being.

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

PSO1: Apply fundamental principles and methods of Computer Science to a wide range of applications.

PSO2: Design, correctly implement and document solutions to significant computational problems.

PSO3: Impart an understanding of the basics of our discipline.

PSO4: Prepare for continued professional development.

PSO5: Understand the impact of the IT analyst solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development.

PSO6: Develop proficiency in the practice of computing.

PSO7: Develop the capacity to study and research independently that will help to develop skills for transition to employment in hardware/software companies.

Anekant Education Society's

Tuljaram Chaturchand College, Baramati

(Empowered Autonomous)

Board of Studies (BOS) in Computer Science

(Academic Year 2025-26 to 2027-28)

Sr.No.	Name of Member	Designation
1.	**Dr. Choudhari Upendra Durgadasrao**	**Chairperson**
2.	**Dr. Kardile Vilas Vasantrao**	Member
3.	**Mr. Mankar Abhijeet Dnyaneshwar**	Member
4.	**Ms. Kulkarni Prajakta Pankaj**	Member
5.	**Ms. Bhagat Asmita Amol**	Member
6.	**Mr. Shah Rahul Adesh**	Member
7.	**Mr. Dixit Purushottam Suresh**	Member
8.	**Dr. Nakate Shashikant C.**	Member
9.	**Ms. Swami Poornima Chandrashekhar**	Member
10.	**Ms. Theurkar Komal Manoj**	Member
11.	**Mr. Chemte Swapnil Pandurang**	Member
12.	**Mrs. Jadhav Lata S.**	Member
13.	**Ms. Gharge J. P.**	Member
14.	**Ms. Shivarkar V. K.**	Member
15.	**Mrs. Shirkande V.Y.**	Member
16.	**Dr. Manisha Bharambe**	Vice-Chancellor Nominee Subject Expert from SPPU, Pune
17.	**Dr. Bhoite Sudhakar D.**	Subject Expert from Outside the Parent University
18.	**Dr. Patki Ulhas S.**	Subject Expert from Outside the Parent University
19.	**Mr. Yadav Preetam**	Representative from industry/corporate sector/allied areas
20.	**Mr. Bhaskar Ranaware**	Member of the College Alumni
21.	**Ms. Sakshi Vargar**	UG Student Representative
22.	**Mr. Adesh Jagtap**	PG Student Representative

Course Structure for F.Y.B.Sc. (Computer Science) (2023 Pattern)

Sem.	Course Type	Course Code	Title of Course	TH/PR	Credits
I	Major Mandatory	COS-101-MJM	Basic Programming using C	Theory	2
	Major Mandatory	COS-102-MJM	DBMS-I	Theory	2
	Major Mandatory	COS-103-MJM	Computer Science Practical – I	Practical	2
	Open Elective (OE)	COS-116-OE	Internet Awareness	Theory	2
	Open Elective (OE)	COS-117-OE	Introduction to MS-Office	Practical	2
	Skill Enhancement Course (SEC) (Any one)	COS-126-SEC(ST) COS-126-SEC(MT) COS-126-SEC(EL)	Introduction to Statistical Software Mathematics for Computer Science Electronics	Practical	2
	Vocational Skill Course (VSC)	COS-121-VSC	Problem Solving Skills & DBMS Using PostgreSQL	Theory	2
	Ability Enhancement Course (AEC)	ENG-131-AEC	Functional English - I	Theory	2
	Value Education Course (VEC)	COS-135-VEC	Environmental Science	Theory	2
	Indian Knowledge System (IKS)	COS-137-IKS	Evolution of Computers	Theory	2
	Co-curricular Course (CC)	---------	To be selected from the Basket	------	2
Total Credits I:					**22**
II	Major Mandatory	COS-151-MJM	Advanced Programming Using C	Theory	2
	Major Mandatory	COS-152-MJM	DBMS-II	Theory	2
	Major Mandatory	COS-153-MJM	Computer Science Practical – II	Practical	2
	Minor (Any one)	COS-161-MN(ST) COS-161-MN(MT) COS-161-MN(EL)	Exploratory Data Analysis-I Discrete Mathematics Fundamentals of Electronics	Theory	2
	Open Elective (OE)	COS-166-OE	Advanced MS-Excel	Practical	2
	Open Elective (OE)	COS-167-OE	E-Banking	Theory	2
	Vocational Skill Course (VSC)	COS-171-VSC	Database Applications using PL/pgSQL	Theory	2
	Skill Enhancement Course (SEC)	COS-176-SEC	Basic Graphics Design using C	Practical	2
	Ability Enhancement Course (AEC)	ENG-181-AEC	Functional English – II	Theory	2
	Value Education Course (VEC)	COS-185-VEC	Digital and Technological Solutions	Theory	2
	Co-curricular Course (CC)	------	To be selected from the Basket	------	2
Total Credits II:					**22**
Cumulative Credits Semester I and II:					**44**

Credit & Course Structure for S. Y. B. Sc. (Computer Science) (2023 Pattern)

Sem	Course Type	Course Code	Title of Course	TH/PR	Credits
Sem-III	**Major Mandatory**	COS-201-MJM	Basic Data Structures	Theory	2
	Major Mandatory	COS-202-MJM	Introduction to Web Technology	Theory	2
	Major Mandatory	COS-203-MJM	Software Engineering Principles and Techniques	Theory	2
	Major Mandatory	COS-204-MJM	Lab Course I – Based on COS-201- MJM, COS-202-MJM	Practical	2
	Minor (Any one) (For B.Sc. (CS)) Statistics, Mathematics, Electronics	COS-211-MN(A), COS-211-MN (B), COS-211-MN(C)		Theory	2
	Minor (Any one) (For B.Sc. (CS)) Statistics, Mathematics, Electronics	COS-212-MN (A), COS-212-N(B), COS-212-MN(C)		Practical	2
	Minor *(For Others)*	COS-211-MN(D)	HTML5 using CSS	Theory	2
	Minor *(For Others)*	COS-212-MN(D)	Lab Course based on COS-211- MN (D)	Practical	2
	Open Elective (OE)	COS-216-OE	Fundamental Concepts in Computer Science	Theory	2
	Vocational Skill Course (VSC)	COS-221-VSC	Programming in C++	Theory	2
	Ability Enhancement Course (AEC)	MAR-231-AEC,	HIN-231-AEC, SAN-231-AEC,	Theory	2
	Co-curricular Course (CC)	YOG/PES/CUL/ NSS/NCC-239-CC	To be selected form the Basket	Theory	2
	Field Project (CEP)	COS-235-FP	Field Project	Practical	2
	Generic IKS Course (IKS)	GEN-245-IKS	Generic IKS	Theory	2
			Total Credits of SEM – III :		**24**

Sem	Course Type	Course Code	Title of course	TH/PR	Credits
	Major Mandatory	COS-251-MJM	Advanced Data Structure	Theory	2
	Major Mandatory	COS-252-MJM	Advanced Web Technology	Theory	2
	Major Mandatory	COS-253-MJM	Java Programming	Theory	2
	Major Mandatory	COS-254-MJM	Lab Course I – Based on COS-251-MJM, COS-252-MJM	Practical	2
	Minor (any one)	COS-261 MN(A), COS-261- MN(B), COS-261-MN(C)	Statistics, Mathematics, Electronics	Theory	2
	Minor (any one)	COS-262- MN(A) COS-262- MN(B) COS-262-MN(C)	Statistics, Mathematics, Electronics	Practical	2

Sem - IV	Minor (For Other)	COS-261-MN(D)	JAVA Script & Bootstrap	Theory	2
	Minor (For Other)	COS-262-MN(D)	Lab Course based on COS-261-MN(D)	Practical	2
	Open Elective (OE)	COS-216-OE	Basic Tools of Digital Marketing	Practical	2
	Skill Enhancement Course (VSC)	COS-276-SEC	Lab Course on COS-253-MJM	Practical	2
	Ability Enhancement Course (AEC)	MAR-231- AEC, HIN-231-AEC , SAN-231-AEC	Marathi, Hindi, Sanskrit	Theory	2
	Co-curricular Course (CC)	YOG/PES/CUL/ NSS/ NCC-239-CC	To be selected form the basket	Theory	2
	Community Engagement Project	COS-285-CEP	Community Engagement Project	Practical	2
Total Credits of SEM – IV					**22**

Credit & Course Structure for T. Y. B. Sc. (Computer Science) (2023 Pattern)
As per NEP-2020

Sem	Course Type	Course Code	Course Title	TH/PR	Credits
V	Major Mandatory	COS-301-MJM	Operating Systems	Theory	02
	Major Mandatory	COS-302-MJM	Theoretical Computer Science	Theory	02
	Major Mandatory	COS-303-MJM	Foundation of Computer Networking	Theory	02
	Major Mandatory	COS-304-MJM	Object Oriented Software Engineering	Theory	02
	Major Mandatory	COS-305-MJM	Lab Course based on COS-306-MJE(A) and COS-306-MJE(B)	Practical	02
	Major Elective (MJE)	COS-306-MJE(A)	PHP Essentials	Theory (Any two)	02
	Major Elective (MJE)	COS-306-MJE(B)	Advanced Java		02
	Major Elective (MJE)	COS-306-MJE(C)	Blockchain Technology		02
	Minor (Any one) (For B.Sc.(CS)) Statistics, Mathematics, Electronics	COS-311-MN(A)	Predictive Analytics	Theory	02
		COS-311-MN(B)	Linear Algebra		
		COS-311-MN(C)	8051 Programming and Applications		
		COS-312-MN(A)	Practical based on Predictive Analytics	Practical	02
		COS-312-MN(B)	Linear Algebra Practical using GeoGebra Software		
		COS-312-MN(C)	8051 Practical Lab		
	Minor (For Others)	COS-311-MN(D)	Web Design using WordPress	Theory	02
		COS-312-MN(D)	Lab Course based on COS-311-MN	Practical	02
	Vocational Skill Course (VSC)	COS-321-VSC	Lab Course based on COS-301-MJM and COS-303-MJM	Practical	02
	Field Project (FP)	COS-335-FP	Field Project	Practical	02
	Total Credits Semester – V				**22**
VI	Major Mandatory	COS-351-MJM	Advanced Operating Systems	Theory	02
	Major Mandatory	COS-352-MJM	Compiler Construction	Theory	02
	Major Mandatory	COS-353-MJM	Higher Layers of Networking and Network Security	Theory	02
	Major Mandatory	COS-354-MJM	Software Metrics and Project Management	Theory	02
	Major Mandatory	COS-355-MJM	Lab Course based on COS-356-MJE(A) and COS-356-MJE(B)	Practical	02
	Major Elective (MJE)	COS-356-MJE(A)	PHP Beyond Basics	Theory (Any two)	02
		COS-356-MJE(B)	Java Web Technologies		02
		COS-356-MJE(C)	Internet of Things		02
	Minor (Any one) (For B.Sc.(CS)) Statistics, Mathematics, Electronics	COS-361-MN(A)	Machine Learning	Theory	02
		COS-361-MN (B)	Computational Geometry		
		COS-361-MN(C)	Arduino and its programming		
		COS-362-MN(A)	Practical based on Machine Learning	Practical	02
		COS-362-MN (B)	Computational Geometry practical using Python programming		
		COS-362-MN(C)	Arduino Lab Experiments		
	Minor (For Others)	COS-361-MN(D)	Business Analysis using Advanced Excel	Theory	02
		COS-362-MN(D)	Lab Course based on COS-361-MN(D)	Practical	02
	On Job Training (OJT)	COS-385-OJT	On Job Training	Practical	04
	Total Credits Semester – VI				**22**
	Grand Total Semester- V + Semester- VI				**44**

T. Y. B. Sc. (Computer Science)

(2023 Pattern)

SEM- VI Syllabus

Implementing from Nov. – 2025

(A.Y.: 2025-26)

SYLLABUS (CBCS as per NEP 2020) FOR T.Y.B. Sc. (Computer Science)
(w. e. from AY 2025-26)

Name of the Programme	**:** B.Sc. Computer Science
Program Code	**:** USCOS
Class	**:** T.Y. B.Sc. (Comp. Sci.)
Semester	**:** VI
Course Type	**:** Major Elective (TH)
Course Name	**:** Advanced Operating System
Course Code	**:** COS-351-MJM
No. of Lectures	**:** 30
No. of Credits	**:** 2

Aim: To understand the design and implementation issues of of Operating System.

Objectives:

- To understand design issues related to memory management and various related algorithms
- To understand design issues related to file management and various related algorithms.
- To understand the structures of different types of Operating System

Learning Outcome:

CO1: Understand memory management techniques, including virtual memory, paging, segmentation, and memoryallocation strategies.

CO2: Explore file system structures and operations, covering topics such as file organization, directory structures, andfile permissions.

CO3: Describe I/O devices and the mechanisms involved in managing input and output operations in an operatingsystem.

CO4: Explain the principles of device management, including device drivers, interrupt handling, and I/O buffering.

CO5: Explore case studies of popular operating systems, such as Unix/Linux, Windows, and Distributed system, tounderstand real-world implementations and design decisions.

CO6: Know security challenges in distributed systems and real-time environments.

CO7: Understand the characteristics of RTOS, including task scheduling, response time analysis, and resourcemanagement.

UNIT No.	Chapter name with Topics	No. of Lectures Required
1.	**Memory Management** 1.1.Background – Basic hardware, Address binding, Logical versus physical address space, Dynamic loading, Dynamic linking and sharedlibraries , Overlays 1.2 Swapping 1.3 Contiguous Memory Allocation – Memory mapping and protection,Memory allocation, Fragmentation MFT MVT 1.4 Paging – Basic Method, Hardware support, Protection, Shared Pages 1.5 Segmentation – Basic concept, Hardware 1.6 Virtual Memory Management – Background, Demand paging, Performance of demand paging, Page replacement – FIFO, OPT, LRU, MFU,LFU, MRU Second chance page replacement 1.7 Thrashing- Locality Model, Working Set Model, Pre-paging, I/OInterlock,	**10**
2.	**Unix Kernel and File Management** 2.1 System Structure, User Perspective, Architecture of Unix Operating System 2.2 Buffer cache: Header, Buffer Pool, Retrieving, Reading and Writing Buffer 2.3 File Representation: inodes : Structure of file Directories, Path conversion to inode, superblock, inode assignment, allocation of disk blocks.	**08**
3.	**I/O Systems** 3.1 Introduction 3.2 I/O Hardware 3.3 Polling, 3.4 Interrupt 3.5 Direct Memory Access 3.6 Application I/O Interface 3.7 Kernel I/O Subsystem- I/O Scheduling, Buffering, Caching , Spooling andDevice Reservation, Error Handling, 3.8 Disk Scheduling- First Come First Served (FCFS), Shortest Seek TimeFirst (SSTF), Scan, C-Scan.	**08**
4.	**Introduction to Distributed Operating System and Real Time Operating Systems** 4.1 Distributed system design goals 4.2 Types of Distributed System 4.3 Architectural Styles- Layered Architecture, Object based architecture,Resource centered architectures, Event based Architecture 4.4 System Architecture- Centralized, Decentralized 4.5 Real Time OS Architecture. 4.6 Real Time OS Scheduling	04

Reference Books

1. Siberchatz, Galvin, Gagne Operating System Concepts - (8th Edition).

2. Pabitra Pal ChoudharyOperatingSystems : Principles and Design – (PHI Learning Private Limited)
3. Maurice J. Bach.The Design of the UNIX Operating System, PHI
4. Mahajan and Seema Shah,Distributed Computing 2ndEditionOXford.
5. MukeshSinghal, Niranjan G ShivaratAdvanced Concepts in Operating Systems
6. Rajkamal, Pedition Mobile Computing Oxford.
7. Jane W.S. Liu, Real Time Operating SystemPearson.

Mapping PO's With CO's

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	2	2	1	1	2	2	1	1	1	1
CO2	3	2	1	2	2	1	1	2	2	1	1	1	1
CO3	3	2	1	2	2	1	1	2	2	1	1	1	1
CO4	3	2	1	2	2	1	1	2	2	1	1	1	1
CO5	3	3	2	2	3	2	3	3	2	2	1	2	2
CO6	3	2	2	2	3	2	2	2	3	2	2	2	2
CO7	3	2	2	2	3	1	2	2	2	1	1	2	1

Justification of Mapping:

PO1: Comprehensive Knowledge and Understanding

CO1 (3): CO1 requires deep understanding of memory management techniques, directly aligning with comprehensive knowledge.
CO2 (3): CO2 demands thorough knowledge of file system structures and operations, strongly supporting PO1.
CO3 (3): CO3 involves detailed understanding of I/O device management mechanisms, aligning with PO1.
CO4 (3): CO4 requires comprehensive knowledge of device management principles, directly supporting PO1.
CO5 (3): CO5 involves in-depth understanding of real-world OS implementations, strongly aligning with PO1.
CO6 (3): CO6 requires deep knowledge of security challenges in distributed systems, directly supporting PO1.
CO7 (3): CO7 demands comprehensive understanding of RTOS characteristics, strongly aligning with PO1.

PO2: Practical, Professional, and Procedural Knowledge

CO1 (2): CO1's focus on memory management has practical applications but emphasizes theory, moderately aligning with PO2.

CO2 (2): CO2's file system operations have practical relevance but are theoretically focused, moderately supporting PO2.
CO3 (2): CO3's I/O management concepts are practically relevant but theoretical, moderately aligning with PO2.
CO4 (2): CO4's device management principles have practical applications but are conceptual, moderately supporting PO2.
CO5 (3): CO5's case studies apply practical knowledge of real-world OS, strongly aligning with PO2.
CO6 (2): CO6's security challenges have practical implications but are theoretical, moderately supporting PO2.
CO7 (2): CO7's RTOS concepts have practical applications in embedded systems but are theoretical, moderately aligning with PO2.

PO3: Entrepreneurial Mindset and Knowledge

CO1 (1): CO1's memory management may inspire system optimization but lacks direct entrepreneurial focus, partially aligning with PO3.
CO2 (1): CO2's file system study may spark storage innovation but is not entrepreneurial, partially supporting PO3.
CO3 (1): CO3's I/O management may inspire hardware innovation but is theoretical, partially aligning with PO3.
CO4 (1): CO4's device management may encourage innovative solutions but is conceptual, partially supporting PO3.
CO5 (2): CO5's case studies may inspire innovative OS designs, moderately aligning with PO3.
CO6 (2): CO6's security challenges may drive innovative solutions, moderately supporting PO3.
CO7 (2): CO7's RTOS study may inspire embedded system innovation, moderately aligning with PO3.

PO4: Specialized Skills and Competencies

CO1 (2): CO1 requires specialized memory management knowledge but focuses on theory, moderately aligning with PO4.
CO2 (2): CO2 involves specialized file system knowledge but is conceptual, moderately supporting PO4.
CO3 (2): CO3 requires specialized I/O management knowledge but is theoretical, moderately aligning with PO4.
CO4 (2): CO4 involves specialized device management knowledge but is not hands-on, moderately supporting PO4.
CO5 (2): CO5 requires specialized OS design knowledge but is analytical, moderately aligning with PO4.
CO6 (2): CO6 involves specialized security knowledge but is theoretical, moderately supporting PO4.
CO7 (2): CO7 requires specialized RTOS knowledge but is conceptual, moderately aligning with PO4.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO1 (2): CO1's memory management involves analytical reasoning but is theoretical, moderately aligning with PO5.
CO2 (2): CO2's file system study requires analytical reasoning but is conceptual, moderately supporting PO5.
CO3 (2): CO3's I/O management involves analytical reasoning but is theoretical, moderately aligning with PO5.
CO4 (2): CO4's device management requires analytical reasoning but is conceptual, moderately supporting PO5.
CO5 (3): CO5's case studies require strong problem-solving and analysis of OS designs, strongly aligning with PO5.
CO6 (3): CO6's security challenges demand problem-solving and analytical reasoning, strongly supporting PO5.
CO7 (3): CO7's RTOS analysis requires problem-solving for scheduling and resource management, strongly aligning with PO5.

PO6: Communication Skills and Collaboration

CO1 (1): CO1's technical focus on memory management lacks communication emphasis, partially aligning with PO6.
CO2 (1): CO2's file system study is individual and technical, partially supporting PO6.
CO3 (1): CO3's I/O management is technical with minimal communication focus, partially aligning with PO6.
CO4 (1): CO4's device management is theoretical and individual, partially supporting PO6.
CO5 (2): CO5's case studies may involve discussing findings, moderately aligning with PO6.

CO6 (2): CO6's security challenges may require discussing solutions, moderately supporting PO6.
CO7 (1): CO7's RTOS study is technical with minimal communication focus, partially aligning with PO6.

PO7: Research-related Skills

CO1 (1): CO1 focuses on established memory management concepts, with minimal research, partially aligning with PO7.
CO2 (1): CO2's file system study uses established knowledge, partially supporting PO7.
CO3 (1): CO3's I/O management focuses on known mechanisms, partially aligning with PO7.
CO4 (1): CO4's device management uses established principles, partially supporting PO7.
CO5 (3): CO5's case studies require researching and analyzing OS implementations, strongly aligning with PO7.
CO6 (2): CO6's security challenges involve researching current issues, moderately supporting PO7.
CO7 (2): CO7's RTOS study may involve researching scheduling algorithms, moderately aligning with PO7.

PO8: Learning How to Learn Skills

CO1 (2): CO1's complex memory management concepts foster self-directed learning, moderately aligning with PO8.
CO2 (2): CO2's file system exploration encourages self-directed learning, moderately supporting PO8.
CO3 (2): CO3's I/O management study promotes self-directed learning, moderately aligning with PO8.
CO4 (2): CO4's device management principles encourage self-directed learning, moderately supporting PO8.
CO5 (3): CO5's case studies strongly promote independent learning of OS designs, strongly aligning with PO8.
CO6 (2): CO6's security challenges foster self-directed learning, moderately supporting PO8.
CO7 (2): CO7's RTOS study encourages self-directed learning, moderately aligning with PO8.

PO9: Digital and Technological Skills

CO1 (2): CO1 involves understanding digital memory systems but is not hands-on, moderately aligning with PO9.
CO2 (2): CO2's file system study involves digital systems but is theoretical, moderately supporting PO9.
CO3 (2): CO3's I/O management involves digital systems but is conceptual, moderately aligning with PO9.
CO4 (2): CO4's device management involves digital systems but is not hands-on, moderately supporting PO9.
CO5 (2): CO5's OS case studies involve digital systems but focus on analysis, moderately aligning with PO9.
CO6 (3): CO6's security in distributed systems directly involves digital technologies, strongly supporting PO9.
CO7 (2): CO7's RTOS study involves digital systems but is theoretical, moderately aligning with PO9.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO1 (1): CO1's technical memory management lacks multicultural focus, partially aligning with PO10.
CO2 (1): CO2's file system study is technical with no multicultural emphasis, partially supporting PO10.
CO3 (1): CO3's I/O management is technical with minimal multicultural focus, partially aligning

with PO10.
CO4 (1): CO4's device management is technical with no multicultural emphasis, partially supporting PO10.
CO5 (2): CO5's case studies may involve diverse OS contexts, moderately aligning with PO10.
CO6 (2): CO6's security challenges may involve global contexts, moderately supporting PO10.
CO7 (1): CO7's RTOS study is technical with minimal multicultural focus, partially aligning with PO10.

PO11: Value Inculcation and Environmental Awareness

CO1 (1): CO1's memory management has no direct value or environmental focus, partially aligning with PO11.
CO2 (1): CO2's file system study lacks direct ethical or environmental focus, partially supporting PO11.
CO3 (1): CO3's I/O management has no direct value or environmental focus, partially aligning with PO11.
CO4 (1): CO4's device management lacks direct ethical or environmental focus, partially supporting PO11.
CO5 (1): CO5's case studies have minimal value or environmental focus, partially aligning with PO11.
CO6 (2): CO6's security challenges relate to ethical data protection, moderately supporting PO11.
CO7 (1): CO7's RTOS study has no direct value or environmental focus, partially aligning with PO11.

PO12: Autonomy, Responsibility, and Accountability

CO1 (1): CO1's theoretical focus has minimal autonomy emphasis, partially aligning with PO12.
CO2 (1): CO2's file system study is conceptual with little autonomy focus, partially supporting PO12.
CO3 (1): CO3's I/O management is theoretical with minimal autonomy, partially aligning with PO12.
CO4 (1): CO4's device management is conceptual with little autonomy, partially supporting PO12.
CO5 (2): CO5's case studies encourage independent analysis, moderately aligning with PO12.
CO6 (2): CO6's security challenges foster responsibility in system design, moderately supporting PO12.
CO7 (2): CO7's RTOS study encourages independent learning, moderately aligning with PO12.

PO13: Community Engagement and Service

CO1 (1): CO1's memory management is technical with no community focus, partially aligning with PO13.
CO2 (1): CO2's file system study is technical with no community focus, partially supporting PO13.
CO3 (1): CO3's I/O management is technical with no community focus, partially aligning with PO13.
CO4 (1): CO4's device management is technical with no community focus, partially supporting PO13.
CO5 (2): CO5's case studies may involve societal OS impacts, moderately aligning with PO13.
CO6 (2): CO6's security challenges impact societal trust, moderately supporting PO13.
CO7 (1): CO7's RTOS study is technical with minimal community focus, partially aligning with PO13.

SYLLABUS (CBCS as per NEP 2020) FOR T.Y.B. Sc. (Computer Science)
(w. e. from AY 2025-26)

Name of the Programme	**:** B.Sc. Computer Science
Program Code	**:** USCOS
Class	**:** T.Y. B.Sc. (Comp. Sci.)
Semester	: VI
Course Type	**:** Major Mandatory (TH)
Course Name	**:** Compiler Construction
Course Code	**:** COS-352-MJM
No. of Lectures	**:** 30
No. of Credits	**:** 2

Prerequisite:
Theoretical Computer Science

Learning Objectives:

Students successfully completing this course will be able:
To understand design issues of a lexical analyzer and use of LEX tool
To understand design issues of a parser and use of YACC tool
To understand issues related to memory allocation
To understand and design code generation schemes

Learning Outcome:

CO1: Students will demonstrate a comprehensive understanding of the purpose, importance, and functioning of compilers in software development.
CO2: Understand the various phases of a compiler and to develop skills in designing a compiler.
CO3: Students will be able to design and implement lexical analysers capable of breaking down source code into tokens.
CO4: Students will construct syntax analysers to generate abstract syntax trees (ASTs) from parsed code.
CO5: Students will generate intermediate code representations from the AST to facilitate optimization and further processing.
CO6: Students will apply various code optimization techniques, such as constant folding and loop optimization, to enhance code efficiency.
CO7: Students will understand the roles of the front-end and back-end in a compiler and their contributions to the compilation process.

Units	Topic Contents	No. of Lectures
Unit–I	**Introduction** Definition of Compiler, Aspects of compilation. The structure of Compiler. Phases of Compiler – Lexical Analysis, Syntax Analysis, Error Handling Introduction to one pass & Multipass compilers, cross compiler, Bootstrapping.	**6**
Unit–II	**Lexical Analysis (Scanner)** Review of Finite automata as a lexical analyzer, Applications of Regular Expressions and Finite Automata (lexical analyzer, searching using RE), Input buffering, Recognition of tokens LEX: A Lexical analyzer generator (Simple Lex Program)	**4**
Unit–III	**Syntax Analysis (Parser)** Definition, Types of Parsers Top-Down Parser and its drawback Top-Down parsing with backtracking, Bottom up parser and its drawback. Elimination of Left Recursion (direct & indirect) Need for Left Factoring & examples Recursive Descent Parsing: Definition Predictive [LL (1)] Parser (Definition, Model) Implementation of Predictive Parser [LL (1)]	**8**
Unit-IV	**Syntax Directed Definition** Syntax Directed Definitions (SDD) Inherited & Synthesized Attributes Evaluating an SDD at the nodes of a Parse Tree, Ex. Evaluation Orders for SDD's Dependency Graph Ordering the Evaluation of Attributes S-Attributed Definition L-Attributed Definition	**8**
Unit–V	**Code Optimization** Intermediate code for expressions – postfix notations, triples and quadruples Expression trees. Code Optimization DAG Diagrams	**4**

References:-

1. Compilers: Principles, Techniques, and Tools ,Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman
2. Principles of Compiler Design By : Alfred V. Aho, Jeffrey D. Ullman (Narosa Publication House)
3. LEX & YACC (O'reilly Publication)

Mapping of this course with Programme Outcomes & Justification

Course Outcomes	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	3	2	2	3	3	2	1	1	1	2	1
CO2	3	3	3	2	2	3	3	3	2	1	1	3	1
CO3	3	3	3	2	1	3	3	2	3	1	1	3	1
CO4	3	3	3	2	1	3	3	3	3	1	1	3	1
CO5	3	3	3	2	1	3	3	2	2	1	1	2	1
CO6	3	3	3	2	1	3	3	3	3	1	1	3	1
CO7	3	3	3	2	1	3	3	2	3	1	1	2	1

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

Justification:

PO1 with All COs:

CO1:PO1: As compilers are fundamental tools in software development, aligning with the application of Computer Science principles.

CO2: PO1: As understanding compiler phases and design is a direct application of fundamental principles in Computer Science.

CO3:PO1: As designing lexical analyzers involves applying fundamental principles to analyze and process source code.

CO4:PO1: As constructing syntax analyzers requires applying principles to understand and represent the structure of code.

CO5:PO1: As generating intermediate code involves applying principles for optimizing and processing code.

CO6:PO1: As applying code optimization techniques directly relates to enhancing the efficiency of software applications.

CO7:PO1: As understanding the roles of compiler components aligns with applying fundamental principles to the compilation process in software development.

PO2 with All COs:

CO1:PO2: As designing and implementing solutions to computational problems often involves utilizing compiler knowledge in software development.

CO2:PO2: As designing a compiler requires the application of design principles, aligning with the objective of designing solutions to computational problems.

CO3:PO2: As designing lexical analyzers is a specific skill that contributes to the broader objective of designing computational solutions.

CO4:PO2: As constructing syntax analyzers is part of the process of designing and implementing solutions to computational problems.

CO5:PO2: As generating intermediate code is a step in the process of implementing solutions to computational problems.

CO6:PO2: As applying optimization techniques is an essential aspect of designing efficient computational solutions.
CO7:PO2: As understanding compiler components contributes to the overall knowledge and skills needed for designing and implementing computational solutions.

PO3 with All COs:

CO1:PO3: As understanding compilers is a fundamental aspect of the discipline and contributes to imparting the basics.
CO2:PO3: As understanding the phases of a compiler is foundational knowledge in the discipline and contributes to imparting the basics.
CO3:PO3: As the ability to design lexical analyzers is a basic skill in the discipline, contributing to imparting the basics.
CO4:PO3: As constructing syntax analyzers is a fundamental skill in the discipline and contributes to imparting the basics.
CO5:PO3: As generating intermediate code is a basic aspect of the discipline and contributes to imparting the basics.
CO6:PO3: As applying code optimization techniques is a fundamental skill in the discipline and contributes to imparting the basics.
CO7:PO3: As understanding compiler components is foundational in the discipline and contributes to imparting the basics.

PO4 with All COs:

CO1:PO4: As understanding compilers contributes to foundational knowledge but may not directly address broader professional development.
CO2:PO4: As knowledge of compiler phases is a specific skill that may be one component of broader professional development.
CO3:PO4: As designing lexical analyzers is a specific skill that contributes to technical expertise but may not cover the full spectrum of professional development.
CO4:PO4: As constructing syntax analyzers is a technical skill that contributes to proficiency but may not directly address broader professional development.
CO5:PO4: As generating intermediate code is a technical skill that adds to technical proficiency but may not cover the entire scope of professional development.
CO6:PO4: As applying optimization techniques is a specific technical skill that contributes to professional development but is not the sole focus.
CO7:PO4: As understanding compiler components is a technical knowledge area that contributes to professional development but may not cover all aspects of it.

PO5 with All COs:

CO1:PO5: As the understanding of compilers is a technical aspect, and its direct connection to societal and environmental impact may be indirect.
CO2:PO5: As the knowledge of compiler phases is essential for technical proficiency, but its direct connection to societal and environmental impact may be indirect.
CO3:PO5: As designing lexical analyzers is more focused on technical aspects and may have limited direct relevance to societal and environmental contexts.
CO4:PO5: - As constructing syntax analyzers is a technical skill that may not directly address societal and environmental impact.

CO5:PO5: - As generating intermediate code is a technical skill with limited direct impact on societal and environmental contexts.
CO6:PO5: As code optimization techniques are technical skills that may not directly address societal and environmental concerns.
CO7:PO5: As understanding compiler components is more technical and may have limited direct relevance to societal and environmental impact.

PO6 with All COs:

CO1:PO6: As understanding compilers is fundamental to developing proficiency in computing.
CO2:PO6: As knowledge of compiler phases and design is essential for proficiency in computing.
CO3:PO6: As the ability to design lexical analyzers is a practical skill contributing to proficiency in computing.
CO4:PO6: As constructing syntax analyzers is a practical skill that enhances proficiency in computing.
CO5:PO6: As generating intermediate code is a practical skill contributing to proficiency in computing.
CO6:PO6: As applying optimization techniques is a practical skill essential for proficiency in computing.
CO7:PO6: As understanding compiler components is practical knowledge contributing to proficiency in computing.

PO7 with All COs:

CO1:PO7: As understanding compilers is a foundational aspect for independent study and research crucial for transitioning to employment.
CO2:PO7: As knowledge of compiler phases and design is essential for independent study and research, contributing to employment readiness.
CO3:PO7: As the ability to design lexical analyzers is a practical skill supporting independent study and research for future employment.
CO4:PO7: As constructing syntax analyzers contributes to the capacity for independent study and research, enhancing readiness for employment.
CO5:PO7: As generating intermediate code is a practical skill supporting independent research and contributing to employment readiness.
CO6:PO7: As applying optimization techniques is a practical skill crucial for independent study and research, preparing for employment.
CO7:PO7: As understanding compiler components is foundational for independent study and research, contributing to employment readiness.

PO8 with All COs:

CO1-PO8: Understand the purpose, importance, and functioning of compilers.

CO2-PO8: Understand compiler phases and develop design skills.

CO3-PO8: Design and implement lexical analyzers.

CO4-PO8: Construct syntax analyzers and generate ASTs. .

CO5-PO8: Generate intermediate code representati

CO6-PO8: Apply code optimization techniques.

CO7: Understand front-end and back-end roles in compilation.

PO9 with All COs:

CO1-PO9*:* Students will demonstrate a comprehensive understanding of the purpose, importance, and functioning of compilers in software development.
CO2-PO9*:* Understand the various phases of a compiler and develop skills in designing a compiler.
CO3-PO9*:* Students will be able to design and implement lexical analysers capable of breaking down source code into tokens.
CO4-PO9*:* Students will construct syntax analysers to generate abstract syntax trees (ASTs) from parsed code.
CO5-PO9*:* Students will generate intermediate code representations from the AST to facilitate optimization and further processing.
CO6-PO9*:* Students will apply various code optimization techniques, such as constant folding and loop optimization, to enhance code efficiency.
CO7-PO9*:* Students will understand the roles of the front-end and back-end in a compiler and their contributions to the compilation process.

PO10 with All COs*:*
CO1-PO10*:* Students will demonstrate a comprehensive understanding of the purpose, importance, and functioning of compilers in software development.
CO2-PO10*:* Understand the various phases of a compiler and to develop skills in designing a compiler.
CO3-PO10*:* Students will be able to design and implement lexical analysers capable of breaking down source code into tokens.
CO4-PO10*:* Students will construct syntax analysers to generate abstract syntax trees (ASTs) from parsed code.
CO5-PO10*:* Students will generate intermediate code representations from the AST to facilitate optimization and further processing.
CO6-PO10*:* Students will apply various code optimization techniques, such as constant folding and loop optimization, to enhance code efficiency.
CO7-PO10*:* Students will understand the roles of the front-end and back-end in a compiler and their contributions to the compilation process.

PO11 with All COs:

CO2-PO11: Understanding compiler phases and compiler design skills.
CO3-PO11: Design and implementation of lexical analysers.
CO4-PO11: Construction of syntax analysers and AST generation.
CO5-PO11: Generating intermediate code representations.
CO6-PO11: Application of code optimization techniques.
CO7-PO11: Understanding front-end and back-end roles in compilation.

PO12 with All COs:

CO1-PO12: Students will demonstrate a comprehensive understanding of the purpose, importance, and functioning of compilers.
CO2-PO12: Understand the various phases of a compiler and develop skills in designing a compiler.
CO3-PO12: Design and implement lexical analysers.
CO4-PO12: Construct syntax analysers to generate ASTs.

CO5-PO12: Generate intermediate code representations.

CO6-PO12: Apply code optimization techniques.

CO7-PO12: Understand the roles of the front-end and back-end in a compiler.

PO13 with All COs:

CO1-PO13: Understanding the purpose, importance, and functioning of compilers.

CO2-PO13: Understanding phases of a compiler and developing design skills.

CO3-PO13: Design and implementation of lexical analysers.

CO4-PO13: Constructing syntax analysers and generating ASTs.

CO5-PO13: Generate intermediate code representations.

CO6-PO13: Apply code optimization techniques.

CO7-PO13: Understand front-end and back-end roles in a compiler.

SYLLABUS (CBCS) FOR T.Y.B.Sc. (Computer Science) (SEM-VI)
Academic Year 2025-2026 (2023 Pattern)

Name of the Programme : B.Sc. Computer Science
Program Code : USCOS
Class : T.Y. B.Sc. (Comp. Sci.)
Semester : VI
Course Type : Major Elective (TH)
Course Name : Higher Layers of Networking and Network Security
Course Code : COS-353-MJM
No. of Lectures : 30
No. of Credits : 2

Pre-requisites: Basics of computer networks covered last semester.
Learning Objectives:

- To enable students to get sound understanding of additional Network concepts,
- Understand importance of network security and cryptography.
- To develop attitude and interest along with necessary knowledge and skills among the students toencourage them to do further academic studies / research in this area, after the completion of this Course.

Learning Outcomes: Learn the security concepts and techniques.
CO1: Addressing, Routing & Controlling - Understand addressing, configure, troubleshoot routing withalgorithms and protocols and traffic controlling.in network.
CO2: Network Transmission and Management – Understand, implement network transmission and know themonitoring tools with their troubleshoot and resolve network issues.
CO3: Internet Technologies - Understand the functions of upper layer technologies, implement andtroubleshoot internet services.
CO4: Network Security – Identify common network security issues, implement security measure, such asfirewalls and encryption to protect network.
CO5: Network Performance Optimization: Analyze and optimize network performance also implementQuality of services (QoS) mechanisms.
CO6: Multimedia base Communications - Understand digitizing, streaming stored and live audio and videocommunication with their protocols.
CO7: Ethical and Legal Considerations – Understand ethical considerations in network design and use.

Unit No	Title & Contents	No. of Lectures
I	**Address Mapping** Protocol (ARP)-Cache Memory, Packet Format, Encapsulation, Operation, FourDifferent Cases, Proxy ARP, RARP, BOOTP, DHCP – Static Address Allocation, Dynamic Address Allocation, Manual and automatic Configuration.	03
II	**The Transport Layer** 3.1 Process-to-Process Delivery Client Server Paradigm, Multiplexing andDe-multiplexing, Connectionless Vs Connection-	07

	Oriented Service, Reliable Vs Unreliable 3.2 User Datagram Protocol (UDP) Datagram Format, Checksum, UDPoperations, Use of UDP 3.3 Transmission Control Protocol (TCP) TCP Services – Process to-ProcessCommunication, Stream Delivery Service, sending and Receiving Buffers, Segments, Full –Duplex Communication, Connection orientedservice, Reliable service. 3.4 TCP Features –Numbering System, Byte Number, Sequence Number,Acknowledgement Number, Flow Control, Error Control, Congestion Control 3.5TCP Segment – Format	
III	**The Application Layer** 3.1 Domain Name System: Name Space-Flat name space, Hierarchical name space Domain Name Space -Label, Domain name, FQDN, PQDN Distribution of Domain Name Space-Hierarchy of name servers, zone, Rootserver, Primary and secondary servers., DNS in the Internet: Generic domains, Country domains, inverse domain,Resolution-Resolver, mapping names to address, mapping addresses to names, recursive resolution, iterative resolution, cachingDNS messages-Header 3.2 Electronic Mail- Architecture-First scenario, second scenario, Third scenario, Fourthscenario, User agent-services of user agent, types of UA Format of e-mailMIME-MIME header, Message transfer agent-SMTP Message Access Agent: POP and IMAP 3.3 File Transfer - FTP-Communication over data control connection, File type, data structure, Transmission mode, anonymous FTP 3.4 WWW- Architecture, Client, Server, URL, Cookies HTTP-HTTP transaction, messages Multimedia: RTP , RTCP 3.5 Devices – Gateways , Transport & Application gateways	10
IV	**Cryptography and Network Security** 4.1 Introduction – Need of security, Security approaches, Security Principles, Types of attacks. Cryptography concepts and Techniques - Plain text and cipher text, Encryption & Decryption, Categories of cryptography- Symmetric key, asymmetric key, comparison, Traditional ciphers Technique – substitution cipher, Transposition cipher. (problem should be covered) 4.2 Symmetric key cryptography-Algorithm types and modes (ECB,CBC,CFB,OFB)Symmetric key algorithm – DES 4.3 Asymmetric key cryptography- RSA 4.4 Communication Security- Firewall, IP Security, Virtual Private Network (VPN). Wireless Security, Web Security.	10

Reference Books:

1) Computer Networks by Andrew Tanenbaum, Pearson Education.[Latest Edition]
2) Data Communication and Networking by Behrouz Forouzan, TATA McGraw Hill.[4th/5thEd.]
3) Networking All In One Dummies Wiley Publication.[5th Edition]
4) Cryptography and Network Security : Atul Kahate
5) Computer Network Security : Kizza, Springer
Network Security – Harrington, Elsevie

Mapping of CO-PO with Justification

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	2	3	2	2	3	2	2	3	3	2	2
CO2	3	3	2	2	3	2	2	3	2	2	3	2	3
CO3	3	3	2	2	3	2	2	3	2	3	3	2	2
CO4	3	3	2	2	3	2	2	3	2		2	3	1
CO5	3	3	2	2	3	2	2	3	2	3	3	2	1
CO6	3	2	3	2	2	3	2	2	3	3	3	2	2
CO7	2	2	3	3	3	3	3	3	2	3	3	2	2

Justification Summary

CO	Justification of Mapping (Rationale)
CO1	Strongly aligned with **PO1–PO5** due to focus on understanding and configuring routing algorithms, analytical reasoning, and practical networking tools. Medium with **PO6, PO12** for communication and accountability in configuration tasks.
CO2	Correlates with **PO1–PO5** for applying network management, monitoring, and troubleshooting. Medium with **PO6** for team collaboration and **PO12** for responsible management.
CO3	Relates to **PO1–PO5, PO9** due to understanding upper-layer technologies and implementation of internet services using digital tools.
CO4	High with **PO1–PO5, PO9**, and **PO11** as it deals with security knowledge, ethical data handling, and professional responsibility.
CO5	Correlates with **PO1–PO5, PO9, PO12** as it involves analysis, optimization, and performance enhancement under accountable project work.
CO6	Linked to **PO1–PO5, PO9** for understanding multimedia protocols, streaming, and implementation using ICT tools.
CO7	Aligned with **PO2, PO10–PO13**, addressing ethics, inclusivity, and societal responsibilities in network design and use.

SYLLABUS (CBCS as per NEP 2020) FOR T.Y.B. Sc. (Computer Science)
(w. e. from AY 2025-26)

Name of the Programme	**:** B.Sc. Computer Science
Program Code	**:** USCOS
Class	**:** T.Y. B.Sc. (Comp. Sci.)
Semester	**:** VI
Course Type	**:** Major Elective (TH)
Course Name	**:** Software Metrics and Project Management
Course Code	**:** COS-354-MJM
No. of Lectures	**:** 30
No. of Credits	**:** 2

Prerequisites: Knowledge of Software Engineering

Aim: To Understand Software metrics and project management and their applicability.

Objectives:

1. To know of how to do project planning for the software process.
2. To learn the cost estimation techniques during the analysis of the project.
3. To understand the quality concepts for ensuring the functionality of the software

Course Outcomes:

CO1: Able to create reliable, replicable cost estimation that links to the requirements of project planning and managing.

CO2 : Students should be able to design and construct a hardware and software system, component, or process to meet desired needs.

CO3 : Students are provided to work on multidisciplinary Problems. Students should be able to work as professionals, with portfolio ranging from data management, network configuration, designing hardware, database and software design to management and administration of entire systems.

CO4 : To understand the fundamental principles of software project management.

CO5 : To have a good knowledge of responsibilities of project manager.

CO6 : To be familiar with the different methods and techniques used for project management

CO7 : Prescribe the conventional and evolution of software.

Title and Contents		No. of Lectures
UNIT 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**
UNIT 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 2.6 Project Communications Management 2.7 Project Risk Management 2.8 Project Procurement Management 2.9 Project Stakeholder Management	**06**
UNIT 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 3.7. estimations, Basis of software Estimation, Software 3.8. estimation techniques, expert Judgment, Estimating by 3.9. analogy. 3.10. Activity Planning: Project schedules, projects and activities, 3.11. sequencing and scheduling Activities, networks planning 3.12. models, Formulating a network model	**10**
UNIT 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.	**08**

	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)	

REFERENCES:

1. Bob Hughes & Mike Cotterell, "Software Project Management", Tata McGraw- HillPublications, Fifth Edition 2012
2. Futrell , "Quality Software Project Management", Pearson Education India, 2008
3. Gobalswamy Ramesh, "Managing Global Software Projects", Tata McGraw HillPublishing Company, 2003
4. Richard H.Thayer "Software Engineering Project Management", IEEE ComputerSociety
5. S. A. Kelkar," Software Project Management" PHI, New Delhi, Third Edition ,2013
6. Roger Pressman "ISE Software Engineering: A Practitioner's Approach" ISE HED IRWINCOMPUTER SCIENCE 9th Edition 2019
7. Kathy Schwalbe "Information Technology Project Management"Cengage Learning Canada Inc.9th Edition
8. Norman Feton, Shari Lawrence pfleeger : Software Metrics : A rigorous and PracticalApproch"PWS Publishing Company, 1997 2nd Edition
9. http://en.wikipedia.org/wiki/Comparison_of_project_management_softwar
10. http://www.ogc.gov.uk/methods_prince_2.asp

Mapping of this course with Programme Outcomes

CO ↓ / PO →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	2	2	3	2	1	2	3	1	1	3	2
CO2	3	3	2	3	3	2	2	2	3	1	2	3	2
CO3	3	3	2	3	3	3	2	2	3	2	2	3	3
CO4	2	2	1	2	2	2	2	2	2	1	1	2	1
CO5	2	2	2	2	2	3	1	2	2	1	2	3	2
CO6	2	2	2	2	2	2	2	2	2	1	1	2	1

CO7	1	2	1	2	2	1	2	2	2	1	2	2	1

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

PO1: Comprehensive Knowledge and Understanding

CO1 to CO7: Each CO provides a strong foundation in core engineering concepts such as cost estimation, design, systems integration, and project management. This aligns with the need for in-depth understanding of the discipline to ensure students grasp comprehensive technical and conceptual knowledge.

PO2: Practical, Professional, and Procedural Knowledge

CO1 to CO7: The course outcomes involve applying project planning, hardware/software design, and interdisciplinary knowledge, which reflects professional practices and procedures necessary in real-world engineering environments.

PO3: Entrepreneurial Mindset and Knowledge

CO2, CO3, CO5, CO6: These outcomes encourage innovation, system design, and managerial decision-making, fostering entrepreneurial thinking and value-driven project execution.

PO4: Specialized Skills and Competencies

CO2 to CO6: These outcomes focus on designing and managing systems with specific technical and managerial skills, contributing to a strong foundation in specialized domains.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO1 to CO7: All COs develop problem-solving capabilities—whether in estimating costs, designing systems, or managing software projects—requiring analytical thinking and sound judgment.

PO6: Communication Skills and Collaboration

CO3, CO5, CO6: These outcomes involve collaborative tasks, team management, and reporting responsibilities, enhancing communication and teamwork skills.

PO7: Research-related Skills

CO2, CO3, CO4, CO6, CO7: These COs involve designing, analyzing, and improving systems or methodologies, fostering skills in applied research and critical evaluation.

PO8: Learning How to Learn Skills

CO1 to CO7: Each outcome contributes to lifelong learning by requiring students to adapt to new tools, methods, and evolving technologies relevant to project management and system design.

PO9: Digital and Technological Skills

CO1 to CO7: All outcomes demand the use of digital tools for estimation, design, database management, and system integration—ensuring students gain competence in digital technologies.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO3, CO6, CO7: These COs involve collaborative work across disciplines and departments, fostering inclusivity and understanding diverse user or team needs

PO11: Value Inculcation and Environmental Awareness

CO3, CO5, CO6: The COs emphasize responsibility, sustainability, and awareness of social and environmental impacts in software and systems development.

PO12: Autonomy, Responsibility, and Accountability

CO1 to CO7: Each CO expects students to work independently or lead teams with accountability, especially in system design, costing, and project execution.

PO13: Community Engagement and Service

CO3, CO6, CO7: These outcomes encourage designing systems and solutions that can positively impact communities and promote social responsibility.

SYLLABUS (CBCS Pattern) For T.Y.B. Sc.(Computer Science) Sem-VI
(w. e. from June, 2025)

Name of the Programme	**:** B.Sc. Computer Science
Program Code	**:** USCOS
Class	**:** T. Y.B. Sc.(Computer Science)
Semester	: VI
Course Type	**:** Major Mandatory (PR)
Course Name	**:** Lab Course based on COS-356-MJE(A) and COS-356-MJE(B)
Course Code	**:** COS-355-MJM
No. of Practical	: 15
No. of Credits	**:** 02

Prerequisites: HTML, Basic PHP, Core Java.

Objectives:

- To learn the latest technologies used with PHP.
- To learn using JSON with PHP.
- To learn AJAX for applying dynamic changes to application.
- To learn package management.
- To learn Java web technologies for building scalable applications.
- To learn hibernate for efficient database management using ORM.
- To understand spring framework's core concepts(DI, IoC, AOP).

Course Outcomes:

CO1: Manage user state with sessions and utilize cookies for client-side storage.
CO2: Master client-side scripting with JavaScript.
CO3: Implement asynchronous data exchange with AJAX.
CO4: Learn framework basics in PHP.
CO5: Implement hibernate ORM and CRUD operations with HQL queries.
CO6: Apply spring framework's DI, IoC, and AOP in applications.
CO7: Compare servlets, JSP and spring MVC for appropriate use in projects.

Unit	Contents
1.	**Assignments on COS-356-MJE(A)** ▪ Assignment on state management using session and cookies. ▪ Assignment on JSON ▪ Assignment on AJAX ▪ Assignment on JavaScript ▪ Assignment on Introduction to frameworks
2.	**Assignments on COS-356-MJE(B)** ▪ Assignment on hibernate ▪ Assignment on Spring framework ▪ Assignment on Servlet and JSP

	▪ Assignment on Spring MVC

Mapping of this course with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	1	3	2	1	1	2	3	1	1	2	1
CO2	3	3	1	3	3	1	1	2	3	1	1	2	1
CO3	3	3	1	3	3	1	2	2	3	1	1	2	1
CO4	3	3	2	3	3	2	2	2	3	1	1	2	1
CO5	3	3	1	3	3	1	2	2	3	1	1	2	1
CO6	3	3	2	3	3	2	2	2	3	1	1	2	1
CO7	3	3	2	3	3	2	3	2	3	1	1	2	1

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

Justification of the mapping

PO1: Comprehensive Knowledge and Understanding

- **CO1 (3 - Strongly related):** Understanding sessions and cookies requires deep knowledge of web application state management, including how servers and clients maintain user data.
- **CO2 (3 - Strongly related):** Requires comprehensive understanding of JavaScript syntax, DOM manipulation, and client-side scripting principles.
- **CO3 (3 - Strongly related):** Deep understanding of asynchronous communication, HTTP requests, and AJAX mechanisms for dynamic web interactions.
- **CO4 (3 - Strongly related):** Understanding PHP frameworks (e.g., Laravel) requires comprehensive knowledge of MVC architecture, routing, and framework-specific conventions.
- **CO5 (3 - Strongly related):** Deep knowledge of Hibernate ORM principles, HQL syntax, and database-object mapping.
- **CO6 (3 - Strongly related):** Comprehensive understanding of Spring's core concepts like Dependency Injection (DI), Inversion of Control (IoC), and Aspect-Oriented Programming (AOP).
- **CO7 (3 - Strongly related):** Deep understanding of Java web technologies (servlets, JSP, Spring MVC) and their architectural differences.

PO2: Practical, Professional, and Procedural Knowledge

- **CO1 (3 - Strongly related):** Implementing sessions and cookies involves practical application in web development workflows, such as user authentication and state persistence.
- **CO2 (3 - Strongly related):** Practical application of JavaScript for dynamic web features like event handling and DOM updates.
- **CO3 (3 - Strongly related):** Practical implementation of AJAX for seamless asynchronous data exchange in web applications.
- **CO4 (3 - Strongly related):** Practical application in building structured, maintainable web apps using PHP frameworks.
- **CO5 (3 - Strongly related):** Practical implementation of database operations using Hibernate ORM and CRUD with HQL queries.

- **CO6 (3 - Strongly related):** Practical application of Spring's DI, IoC, and AOP in building modular, enterprise-level Java applications.
- **CO7 (3 - Strongly related):** Practical knowledge of selecting and implementing servlets, JSP, or Spring MVC based on project requirements.

PO3: Entrepreneurial Mindset and Knowledge

- **CO1 (1 - Partially related):** Limited direct relevance to entrepreneurship, though state management supports scalable web applications, which could indirectly aid entrepreneurial ventures.
- **CO2 (1 - Partially related):** Limited entrepreneurial application unless building client-side startups or dynamic user interfaces for business purposes.
- **CO3 (1 - Partially related):** Indirect entrepreneurial use in building responsive, user-friendly apps that could support business goals.
- **CO4 (2 - Moderately related):** PHP frameworks enable rapid development of scalable apps, relevant to entrepreneurial ventures requiring quick prototyping.
- **CO5 (1 - Partially related):** Limited entrepreneurial relevance unless building data-driven startups leveraging ORM for efficiency.
- **CO6 (2 - Moderately related):** Spring's scalability and modularity support entrepreneurial app development for enterprise solutions.
- **CO7 (2 - Moderately related):** Choosing appropriate tech stacks (servlets, JSP, Spring MVC) supports entrepreneurial decisions for cost-effective and scalable projects.

PO4: Specialized Skills and Competencies

- **CO1 (3 - Strongly related):** Managing user state with sessions and cookies is a specialized skill in web programming.
- **CO2 (3 - Strongly related):** JavaScript scripting is a core specialized skill for front-end development.
- **CO3 (3 - Strongly related):** AJAX is a specialized skill for creating seamless, asynchronous user experiences.
- **CO4 (3 - Strongly related):** Specialized skill in using PHP frameworks for rapid, structured web development.
- **CO5 (3 - Strongly related):** Specialized skill in database abstraction and ORM tools like Hibernate for efficient data management.
- **CO6 (3 - Strongly related):** Specialized skill in leveraging Spring's DI, IoC, and AOP for enterprise-level Java applications.
- **CO7 (3 - Strongly related):** Specialized skill in evaluating and applying Java web frameworks (servlets, JSP, Spring MVC) for specific project needs.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

- **CO1 (2 - Moderately related):** Involves problem-solving for session persistence and cookie management, but less analytical complexity compared to other COs.
- **CO2 (3 - Strongly related):** Requires problem-solving for event handling, DOM manipulation, and analytical reasoning for JavaScript logic.
- **CO3 (3 - Strongly related):** Requires problem-solving for asynchronous data handling, error management, and optimizing AJAX requests.
- **CO4 (3 - Strongly related):** Involves problem-solving in configuring and debugging PHP framework components, with analytical reasoning for MVC implementation.

- **CO5 (3 - Strongly related):** Analytical reasoning for mapping objects to database tables and optimizing HQL queries in Hibernate.
- **CO6 (3 - Strongly related):** Analytical reasoning for configuring DI, IoC, and AOP aspects in Spring applications.
- **CO7 (3 - Strongly related):** Analytical reasoning to compare performance, scalability, and use cases of servlets, JSP, and Spring MVC.

PO6: Communication Skills and Collaboration

- **CO1 (1 - Partially related):** Minimal focus on communication or collaboration unless implemented in team-based projects.
- **CO2 (1 - Partially related):** Limited communication/collaboration focus unless JavaScript development occurs in a team setting.
- **CO3 (1 - Partially related):** Minimal communication/collaboration unless AJAX is used in collaborative projects.
- **CO4 (2 - Moderately related):** Collaboration may occur in team-based PHP framework projects, such as shared codebase management.
- **CO5 (1 - Partially related):** Minimal communication/collaboration focus unless Hibernate is used in team-driven database projects.
- **CO6 (2 - Moderately related):** Collaboration in team-based Spring projects, especially in enterprise settings with shared configurations.
- **CO7 (2 - Moderately related):** May involve collaboration when discussing or justifying technology choices in team settings.

PO7: Research-related Skills

- **CO1 (1 - Partially related):** Limited research component unless exploring advanced state management techniques.
- **CO2 (1 - Partially related):** Limited research unless exploring advanced JavaScript frameworks or libraries.
- **CO3 (2 - Moderately related):** May involve researching AJAX libraries (e.g., jQuery, Axios) or performance optimization techniques.
- **CO4 (2 - Moderately related):** Researching PHP framework documentation or plugins enhances development skills.
- **CO5 (2 - Moderately related):** Researching Hibernate configurations or HQL optimizations for efficient database operations.
- **CO6 (2 - Moderately related):** Researching Spring modules, best practices, or aspect configurations.
- **CO7 (3 - Strongly related):** Requires researching strengths, weaknesses, and use cases of servlets, JSP, and Spring MVC for informed comparisons.

PO8: Learning How to Learn Skills

- **CO1 (2 - Moderately related):** Requires learning session and cookie mechanisms and adapting to various use cases.
- **CO2 (2 - Moderately related):** Learning JavaScript involves adapting to evolving standards (e.g., ES6+ features).
- **CO3 (2 - Moderately related):** Learning AJAX requires understanding evolving web technologies like the Fetch API.

- **CO4 (2 - Moderately related):** Learning PHP frameworks involves adapting to best practices and framework updates.
- **CO5 (2 - Moderately related):** Learning Hibernate requires adapting to complex ORM patterns and database integration.
- **CO6 (2 - Moderately related):** Learning Spring involves adapting to its extensive ecosystem and updates.
- **CO7 (2 - Moderately related):** Learning to evaluate and compare frameworks enhances adaptability and self-learning skills.

PO9: Digital and Technological Skills

- **CO1 (3 - Strongly related):** Directly involves web technologies and client-server interactions for state management.
- **CO2 (3 - Strongly related):** Core digital skill for client-side web development using JavaScript.
- **CO3 (3 - Strongly related):** Core digital skill for modern web development with asynchronous data exchange.
- **CO4 (3 - Strongly related):** Core technological skill for backend development using PHP frameworks.
- **CO5 (3 - Strongly related):** Core technological skill for backend database management with Hibernate ORM.
- **CO6 (3 - Strongly related):** Core technological skill for Java backend development with Spring.
- **CO7 (3 - Strongly related):** Core digital skill for Java web development with servlets, JSP, and Spring MVC.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- **CO1 (1 - Partially related):** Minimal connection to cultural or inclusive aspects unless building globally accessible apps.
- **CO2 (1 - Partially related):** Little connection to multicultural competence unless JavaScript supports inclusive UI design.
- **CO3 (1 - Partially related):** No direct multicultural relevance unless AJAX enhances inclusive user experiences.
- **CO4 (1 - Partially related):** Limited multicultural connection unless PHP apps are built for diverse audiences.
- **CO5 (1 - Partially related):** No multicultural relevance unless database designs consider diverse data needs.
- **CO6 (1 - Partially related):** Limited multicultural relevance unless Spring apps address diverse user bases.
- **CO7 (1 - Partially related):** No multicultural relevance unless framework choices consider inclusive project requirements.

PO11: Value Inculcation and Environmental Awareness

- **CO1 (1 - Partially related):** No direct link to values or environmental concerns.
- **CO2 (1 - Partially related):** No direct environmental or value-based focus.
- **CO3 (1 - Partially related):** No environmental or value-based connection.
- **CO4 (1 - Partially related):** No direct environmental/value focus.
- **CO5 (1 - Partially related):** No environmental/value connection.

- **CO6 (1 - Partially related):** No environmental/value focus.
- **CO7 (1 - Partially related):** No environmental/value connection.

PO12: Autonomy, Responsibility, and Accountability

- **CO1 (2 - Moderately related):** Managing user data responsibly (e.g., secure sessions) ties to accountability.
- **CO2 (2 - Moderately related):** Writing reliable JavaScript code fosters responsibility for client-side functionality.
- **CO3 (2 - Moderately related):** Responsible handling of asynchronous data ensures reliable app performance.
- **CO4 (2 - Moderately related):** Responsible use of PHP frameworks ensures maintainable, secure code.
- **CO5 (2 - Moderately related):** Responsible database design with Hibernate ensures data integrity and reliability.
- **CO6 (2 - Moderately related):** Responsible use of Spring ensures robust, maintainable applications.
- **CO7 (2 - Moderately related):** Responsible technology selection (servlets, JSP, Spring MVC) ensures project success and reliability.

PO13: Community Engagement and Service

- **CO1 (1 - Partially related):** Little relevance to community engagement unless apps serve community needs.
- **CO2 (1 - Partially related):** Minimal community engagement unless JavaScript is used in public-facing apps.
- **CO3 (1 - Partially related):** Minimal community engagement unless AJAX supports community-driven apps.
- **CO4 (1 - Partially related):** Minimal community engagement unless PHP apps address community needs.
- **CO5 (1 - Partially related):** Minimal community engagement unless database apps serve community purposes.
- **CO6 (1 - Partially related):** Minimal community engagement unless Spring apps address community needs.
- **CO7 (1 - Partially related):** Minimal community engagement unless framework choices support community-oriented projects.

SYLLABUS (CBCS as per NEP1.0 2023 Pattern) For T.Y.B. Sc.(Computer Science) Sem-VI

(w. e. from June, 2025)

Name of the Programme	**:** B.Sc. Computer Science
Program Code	**:** USCOS
Class	**:** T. Y.B. Sc.(Computer Science)
Semester	: VI
Course Type	**:** Major Elective (TH)
Course Name	**:** PHP Beyond Basics
Course Code	**:** COS-356-MJE(A)
No. of Lectures	: 30
No. of Credits	**:** 02

Prerequisites: HTML, CSS, Basic PHP

Objectives:

- To learn the latest technologies used with PHP.
- To learn using JSON with PHP.
- To learn AJAX for applying dynamic changes to application.
- To learn package management.

Course Outcomes:

CO1: Develop dynamic and interactive web applications.
CO2: Manage user state with sessions and utilize cookies for client-side storage.
CO3: Secure web applications.
CO4: Master client-side scripting with JavaScript.
CO5: Implement asynchronous data exchange with AJAX.
CO6: Integrate font-end and back-end technologies.
CO7: Design and troubleshoot advanced web applications.

Unit	Contents	No. of Lectures Required
1.	**Web Techniques** -Variables -Server information -Processing forms -Setting response headers -State management -Introduction to JSON -JSON syntax -Datatypes in JSON -JSON Vs XML -Encoding JSON in PHP -Decoding JSON in PHP	**10**

2.	**AJAX** -Introduction to AJAX -AJAX web application model -AJAX-PHP framework -Performing AJAX validation -Connecting database using php and AJAX	**06**
3.	**Intermediate JavaScript** - Objects - Constructor Functions - Factory Functions - Constructor Method - New keyword - this in methods - this in functions declarations - this in events - this in classes - windows scope - Prototypes and ES6 Classes - Built-in constructor functions - Constructor property - Inheritance - Async/ Await - Promises -Array Iteration Methods - forEach - Map - Filter - Reduce -String Manipulations - trim and split methods - toUpperCase and toLowerCase methods - includes method	**10**
4.	**Collaborative Platform** Package management Frameworks like CodeIgniter, Symfony, Laravel - Installation - Features	**04**

References:

1. Kevin Tatroe, Peter MacIntyre(2020), Programming PHP:Creating Dynamic Web Pages(4th ed.). O'Reilly.

Web References:

1. https://www.php.net/manual/en/manual.php
2. https://www.php-fig.org/
3. https://phptherightway.com

4. https://w3schools.com

Mapping of this course with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	2	3	3	2	1	1	3	1	1	2	1
CO2	2	3	1	3	2	1	1	1	3	1	1	2	1
CO3	2	3	1	3	3	1	1	1	3	1	2	2	1
CO4	3	3	1	3	2	1	1	1	3	1	1	2	1
CO5	2	3	1	3	3	1	1	1	3	1	1	2	1
CO6	3	3	2	3	3	2	1	1	3	1	1	2	1
CO7	3	3	2	3	3	2	2	2	3	1	2	2	1

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

Justification:

PO1: Comprehensive Knowledge and Understanding

- **CO1 (3)**: Developing dynamic and interactive web applications requires comprehensive knowledge of web development concepts, including HTML, CSS, and JavaScript, to create functional and user-friendly applications.
- **CO2 (2)**: Managing user state with sessions and cookies requires understanding of state management concepts, though it is less broad than the comprehensive knowledge needed for full application development.
- **CO3 (2)**: Securing web applications requires knowledge of security principles, such as encryption and authentication, but is narrower in scope compared to full application development.
- **CO4 (3)**: Mastering client-side scripting with JavaScript demands deep knowledge of JavaScript syntax, functions, and DOM manipulation, central to web development.
- **CO5 (2)**: Implementing asynchronous data exchange with AJAX requires understanding of asynchronous programming concepts, though it is a more specific subset of web development knowledge.
- **CO6 (3)**: Integrating front-end and back-end technologies necessitates comprehensive knowledge of full-stack development, including both client-side and server-side technologies.
- **CO7 (3)**: Designing and troubleshooting advanced web applications requires deep knowledge of advanced web development concepts, including architecture and debugging techniques.

PO2: Practical, Professional, and Procedural Knowledge

- **CO1 (3)**: Developing dynamic and interactive web applications involves professional skills in applying web development frameworks and tools to build functional applications.
- **CO2 (3)**: Managing user state with sessions and cookies involves professional techniques for implementing and maintaining secure and efficient state management systems.
- **CO3 (3)**: Securing web applications requires professional practices, such as implementing security protocols and following best practices for data protection.

- **CO4 (3)**: Mastering client-side scripting with JavaScript involves professional skills in writing efficient and maintainable scripts for interactive features.
- **CO5 (3)**: Implementing asynchronous data exchange with AJAX requires professional skills in applying AJAX techniques for seamless data communication.
- **CO6 (3)**: Integrating front-end and back-end technologies involves professional skills in combining technologies to create cohesive, full-stack applications.
- **CO7 (3)**: Designing and troubleshooting advanced web applications requires professional expertise in designing robust systems and resolving complex issues.

PO3: Entrepreneurial Mindset and Knowledge

- **CO1 (2)**: Developing web applications may inspire entrepreneurial ideas, such as creating web-based startups or innovative applications, though not the primary focus.
- **CO2 (1)**: Managing user state with sessions and cookies has limited entrepreneurial relevance unless applied to specific business models, such as personalized user experiences.
- **CO3 (1)**: Securing web applications has limited entrepreneurial relevance unless applied to security-focused products or services.
- **CO4 (1)**: Mastering client-side scripting with JavaScript has limited entrepreneurial relevance unless applied to specific innovative products.
- **CO5 (1)**: Implementing AJAX has limited entrepreneurial relevance unless used in applications with unique data-driven features.
- **CO6 (2)**: Integrating front-end and back-end technologies may inspire entrepreneurial ideas for full-stack solutions or scalable platforms.
- **CO7 (2)**: Designing and troubleshooting advanced web applications may inspire entrepreneurial ideas for innovative or high-performance web solutions.

PO4: Specialized Skills and Competencies

- **CO1 (3)**: Developing dynamic and interactive web applications requires specialized skills in web development frameworks, tools, and technologies.
- **CO2 (3)**: Managing user state requires specialized skills in handling sessions and cookies for efficient user data management.
- **CO3 (3)**: Securing web applications demands specialized skills in security protocols, encryption, and vulnerability mitigation.
- **CO4 (3)**: Mastering client-side scripting with JavaScript requires specialized skills in JavaScript programming and DOM manipulation.
- **CO5 (3)**: Implementing asynchronous data exchange with AJAX requires specialized skills in asynchronous programming and API integration.
- **CO6 (3)**: Integrating front-end and back-end technologies requires specialized skills in full-stack frameworks and server-client communication.
- **CO7 (3)**: Designing and troubleshooting advanced web applications demands specialized skills in advanced design patterns and debugging techniques.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

- **CO1 (3)**: Developing dynamic and interactive web applications involves problem-solving to create user-friendly and efficient applications.
- **CO2 (2)**: Managing user state requires problem-solving to ensure effective and secure data management, though less complex than full application development.

- **CO3 (3)**: Securing web applications involves strong problem-solving to identify and mitigate security vulnerabilities.
- **CO4 (2)**: Mastering client-side scripting requires problem-solving to address scripting challenges, though more focused than full application design.
- **CO5 (3)**: Implementing AJAX requires problem-solving to ensure efficient and reliable asynchronous data exchange.
- **CO6 (3)**: Integrating front-end and back-end technologies demands problem-solving to ensure seamless communication and functionality.
- **CO7 (3)**: Designing and troubleshooting advanced web applications requires strong analytical reasoning to resolve complex issues and optimize performance.

PO6: Communication Skills and Collaboration

- **CO1 (2)**: Developing web applications may require collaboration in team-based projects and communication of design ideas to stakeholders.
- **CO2 (1)**: Managing user state has minimal collaboration requirements unless part of a larger team effort.
- **CO3 (1)**: Securing web applications typically involves minimal collaboration unless working in team-based security projects.
- **CO4 (1)**: Mastering client-side scripting is primarily an individual task with minimal collaboration needs.
- **CO5 (1)**: Implementing AJAX is typically an individual technical task with minimal collaboration.
- **CO6 (2)**: Integrating front-end and back-end technologies may involve collaboration in full-stack team projects to align client and server components.
- **CO7 (2)**: Designing and troubleshooting advanced applications may involve collaboration in complex projects and communicating solutions effectively.

PO7: Research-related Skills

- **CO1 (1)**: Limited research is required unless exploring new frameworks or tools for web development.
- **CO2 (1)**: Limited research unless exploring new state management techniques or tools.
- **CO3 (1)**: Limited research unless investigating new security methods or vulnerabilities.
- **CO4 (1)**: Limited research unless exploring advanced JavaScript features or libraries.
- **CO5 (1)**: Limited research unless exploring new AJAX techniques or APIs.
- **CO6 (1)**: Limited research unless investigating new integration methods or frameworks.
- **CO7 (2)**: Troubleshooting advanced applications may require research into novel issues or advanced techniques.

PO8: Learning How to Learn Skills

- **CO1 (1)**: Learning new tools or frameworks for web development is partially relevant but not the primary focus.
- **CO2 (1)**: Learning new state management techniques is partially relevant but not central.
- **CO3 (1)**: Learning security practices is partially relevant but not the main focus.
- **CO4 (1)**: Learning JavaScript techniques is partially relevant but not the primary outcome.
- **CO5 (1)**: Learning AJAX techniques is partially relevant but not the core focus.
- **CO6 (1)**: Learning integration techniques is partially relevant but not the main objective.

- **CO7 (2)**: Designing and troubleshooting advanced applications involves learning advanced techniques and adapting to new challenges.

PO9: Digital and Technological Skills

- **CO1 (3)**: Developing dynamic and interactive web applications directly involves digital and technological skills in web development.
- **CO2 (3)**: Managing user state with sessions and cookies directly involves digital skills for client-side storage and server-side management.
- **CO3 (3)**: Securing web applications directly involves digital skills for implementing security measures and protocols.
- **CO4 (3)**: Mastering client-side scripting with JavaScript directly involves digital skills in scripting and interactivity.
- **CO5 (3)**: Implementing asynchronous data exchange with AJAX directly involves digital skills for asynchronous communication.
- **CO6 (3)**: Integrating front-end and back-end technologies directly involves digital skills in full-stack development.
- **CO7 (3)**: Designing and troubleshooting advanced web applications directly involves advanced digital skills in development and debugging.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- **CO1 (1)**: Minimal focus on multicultural competence or empathy unless applications are designed for diverse audiences.
- **CO2 (1)**: Minimal focus on multicultural competence, as state management is a technical task.
- **CO3 (1)**: Minimal focus on multicultural competence, though security may consider user privacy across contexts.
- **CO4 (1)**: Minimal focus on multicultural competence, as scripting is a technical task.
- **CO5 (1)**: Minimal focus on multicultural competence, as AJAX is a technical implementation.
- **CO6 (1)**: Minimal focus on multicultural competence unless applications target diverse users.
- **CO7 (1)**: Minimal focus on multicultural competence, though inclusive design (e.g., accessibility) may apply.

PO11: Value Inculcation and Environmental Awareness

- **CO1 (1)**: Limited focus on value inculcation or environmental awareness unless applications promote ethical or sustainable goals.
- **CO2 (1)**: Limited focus on values or environmental awareness, as state management is technical.
- **CO3 (2)**: Securing web applications aligns with ethical values, such as protecting user privacy and data integrity.
- **CO4 (1)**: Limited focus on values or environmental awareness, as scripting is technical.
- **CO5 (1)**: Limited focus on values or environmental awareness, as AJAX is technical.
- **CO6 (1)**: Limited focus on values unless applications promote ethical or sustainable outcomes.
- **CO7 (2)**: Designing advanced applications may involve ethical considerations, such as accessibility or sustainable design practices.

PO12: Autonomy, Responsibility, and Accountability

- **CO1 (2)**: Developing web applications requires responsibility for delivering functional and reliable applications.
- **CO2 (2)**: Managing user state involves responsibility for secure and reliable data management.
- **CO3 (2)**: Securing web applications requires responsibility for ensuring user data protection and system integrity.
- **CO4 (2)**: Mastering client-side scripting involves responsibility for writing reliable and efficient scripts.
- **CO5 (2)**: Implementing AJAX requires responsibility for ensuring reliable and efficient data exchange.
- **CO6 (2)**: Integrating front-end and back-end technologies requires responsibility for robust and cohesive systems.
- **CO7 (2)**: Designing and troubleshooting advanced applications requires responsibility for delivering robust and optimized solutions.

PO13: Community Engagement and Service

- **CO1 (1)**: Minimal community engagement unless applications are designed to serve community needs.
- **CO2 (1)**: Minimal community engagement, as state management is a technical task.
- **CO3 (1)**: Minimal community engagement unless security measures protect community data.
- **CO4 (1)**: Minimal community engagement, as scripting is a technical task.
- **CO5 (1)**: Minimal community engagement, as AJAX is a technical implementation.
- **CO6 (1)**: Minimal community engagement unless applications serve community purposes.
- **CO7 (1)**: Minimal community engagement unless advanced applications are designed for community benefit.

SYLLABUS (CBCS as per NEP 2020) FOR T.Y.B. Sc. (Computer Science)
(w. e. from AY 2025-26)

Name of the Programme	**:** B.Sc. Computer Science
Program Code	**:** USCOS
Class	**:** T.Y. B.Sc. (Comp. Sci.)
Semester	**:** VI
Course Type	**:** Major Elective (TH)
Course Name	**:** Java Web Technologies
Course Code	**:** COS-356-MJE(B)
No. of Lectures	**:** 30
No. of Credits	**:** 2

Prerequisites:

- Proficiency in Core Java (OOP, classes, exception handling).
- Basic knowledge of HTML, CSS, and JavaScript.
- Understanding of relational databases and SQL.
- Familiarity with Java EE basics (servlets, JSP basics).
- Basic understanding of XML for configuration.

Course Objectives:

- Master Java web technologies for building scalable applications.
- Learn Hibernate for efficient database management using ORM.
- Understand Spring Framework's core concepts (DI, IoC, AOP).
- Develop web applications using Servlets, JSP, and Spring MVC.
- Apply web development principles using client-server architecture.

Course Outcome:

CO1: Implement Hibernate ORM and CRUD operations with HQL queries.

CO2: Apply Spring Framework's DI, IoC, and AOP in applications.

CO3: Develop dynamic web applications using Servlets and JSP.

CO4: Configure and deploy Servlets using web.xml and handle requests/responses.

CO5: Utilize JSP directives, scripting elements, and implicit objects effectively.

CO6: Build Spring MVC applications with multiple views, controllers, and form handling.

CO7: Compare Servlets, JSP, and Spring MVC for appropriate use in projects.

UNIT No.	Chapter Name with Topics	No. of Lectures Required
UNIT- I	**Hibernate** - Hibernate Basics - Hibernate ORM Features - Hibernate project - Hibernate Annotations - Hibernate CRUD Operations - - HQL	**07**
UNIT- II	**Spring Framework** - Introduction and Application - Advantages of Spring Framework - DI, IoC and AOP - Architecture / Modules - Autowiring - IoC Containers - Bean Definition - Bean Scopes - Bean Life Cycle	**07**
UNIT-III	**Java Server Pages** - Internet basics and Web Architecture - Client-Server Model - Static vs Dynamic Web Pages - Introduction to Web Servers (Apache Tomcat) - Role of Servlets and JSP in Web Development - What is JSP? and Advantages of JSP over Servlets - JSP Architecture and Lifecycle - JSP Directives (page, include, taglib) - JSP Scripting Elements and Implicit Objects	**07**
UNIT-IV	**Spring MVC** - Concept of Model–View–Controller Pattern - How MVC simplifies web development - Comparison: Servlet/JSP MVC vs Spring MVC - Architecture of Spring MVC - Spring MVC Request Flow - Front Controller: DispatcherServlet - Handler Mapping and Controller - View Resolver and View Components - Role of Model, View, and Controller classes - Writing the Controller Class using @Controller Annotation - Mapping Requests using @RequestMapping - Using Model, ModelMap, and ModelAndView objects - Passing Data from Controller to View	**09**

Programme Outcomes and Course Outcomes Mapping:

Here's the mapping table:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	1	3	3	1	1	2	3	1	1	2	1
CO2	3	3	1	3	3	1	1	2	3	1	1	2	1
CO3	2	3	1	3	3	1	1	2	3	1	1	3	1
CO4	2	3	1	3	3	1	1	2	3	1	1	3	1
CO5	3	3	1	3	3	1	1	2	3	1	1	2	1
CO6	2	3	1	3	3	1	1	2	3	1	1	3	1
CO7	3	2	1	2	3	1	2	3	2	1	1	1	1

PO1: Comprehensive Knowledge and Understanding

- CO1 to CO7: Each CO provides a strong foundation in Java web technologies concepts, methods, and their applications. This aligns well with the need for a profound understanding of foundational theories, principles, methodologies, and key concepts in the field.

PO2: Practical, Professional, and Procedural Knowledge

- CO1 to CO7: Understanding and applying web development methods and tools are essential for professional tasks within the field. Students will gain practical skills such as ORM implementation, framework usage, and application deployment.

PO3: Entrepreneurial Mindset and Knowledge

- CO1 to CO7: The technical skills in building web applications can indirectly foster innovation, opportunity identification, and understanding of market dynamics for creating tech-based businesses, though not the primary focus.

PO4: Specialized Skills and Competencies

- CO1 to CO7: The course fosters proficiency in technical skills, analytical abilities, problem-solving, and adaptability in web development contexts.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

- CO1 to CO7: Graduates will apply concepts in practical settings, solve complex problems, and analyze technologies effectively, requiring critical thinking and creativity.

PO6: Communication Skills and Collaboration

- CO1 to CO7: Developing web applications involves documenting code and potentially collaborating on projects, which supports basic communication of complex ideas, though not emphasized directly.

PO7: Research-related Skills

- CO1 to CO7: Comparative analysis and inquiry into technologies touch on formulating questions, data evaluation, and ethical research practices in tech selection.

PO8: Learning How to Learn Skills

- CO1 to CO7: Encourages self-directed learning, adaptation to new frameworks, and independent goal-setting in technology mastery.

PO9: Digital and Technological Skills

- CO1 to CO7: Strong focus on using ICT, software tools, and data handling in web technologies.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- CO1 to CO7: Web applications can be designed for diverse users, promoting indirect understanding of multicultural perspectives, though not a core element.

PO11: Value Inculcation and Environmental Awareness

- CO1 to CO7: Ethical coding practices and efficient resource use in development subtly align with responsible citizenship and sustainability, such as optimizing for energy-efficient apps.

PO12: Autonomy, Responsibility, and Accountability

- CO1 to CO7: Promotes independent application of knowledge, project management, and accountability in development tasks.

PO13: Community Engagement and Service

- CO1 to CO7: Skills in web technologies can be applied to create applications for community benefit, such as service-oriented tools, though not directly taught.

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

Name of the Programme	**:** For T.Y.UG Sem -VI
Program Code	**:** USCOS
Class	**:** T.Y.U.G
Semester	**: VI**
Course Type	**:** Minor for TY UG (TH)
Course Name	**:** Business Analysis using Advanced Excel (TH)
Course Code	**:** COS-361-MN (D)
No. of Lectures	**: 30**
No. of Credits	**: 02**

Prerequisites:

- Basic knowledge of computers and Microsoft Excel.
- Understanding of basic business concepts such as sales, cost, and profit.

Course Objectives:

1: To provide knowledge of Microsoft Excel tools and techniques used for business analysis and decision-making .

2: To develop analytical thinking through the use of advanced formulas and data functions in Excel.

3: To enable students to summarize, visualize, and interpret business data effectively using dashboards.

4: To introduce forecasting, data modeling, and automation concepts for business reporting.

5: To enable students to use Power Query, Power Pivot, and VBA for data analysis and automating processes.

6: To familiarize students with Analysis ToolPak for performing descriptive statistics and regression analysis.

7: To empower students to design automated reports and dashboards to support data-driven decision-making.

Course Outcomes:

CO1: Understand the role of Excel in data management and business decision-making.
CO2: Apply advanced Excel functions and analytical tools to perform complex business computations.
CO3: Design interactive dashboards and charts for effective business data visualization.
CO4: Perform forecasting, business modeling, and scenario analysis using Excel tools.
CO5: Demonstrate the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros.
CO6: Use Analysis ToolPak for descriptive statistics, regression analysis, and other business analyticsTasks.
CO7: Develop skills to create automated, insightful reports and dashboards to support data-driven decision-making.

Unit	Title and Contents	No. of Lectures
Unit 1	**Introduction to Business Analysis & Excel Basics** 1.1 Concept and Importance of Business Analysis 1.2 Role of Excel in Business Decision-Making 1.3 Excel Interface, Shortcuts, and Data Entry 1.4 Data Cleaning – Remove Duplicates, Text to Columns, TRIM, CLEAN 1.5 Conditional Formatting and Data Validation	07
Unit 2	**Advanced Excel Functions for Business Analysis** 2.1 Logical Functions – IF, AND, OR, IFERROR 2.2 Lookup and Reference Functions – VLOOKUP, INDEX, MATCH 2.3 Text Functions – LEFT, RIGHT, MID, CONCAT 2.4 Date and Time Functions – TODAY, NETWORKDAYS, EOMONTH 2.5 Statistical and Financial Functions – SUMIFS, COUNTIFS, AVERAGEIFS, NPV, IRR	08
Unit 3	**Data Analysis, Visualization & Dashboards** 3.1 Pivot Tables and Pivot Charts – Creation and Customization 3.2 What-If Analysis – Goal Seek, Scenario Manager, Data Table 3.3 Solver Tool – Introduction to Optimization 3.4 Charts and Visual Representation – Column, Line, Pie, Combo, Waterfall 3.5 Dashboard Design – Charts, Tables, Slicers, KPIs	08
Unit 4	**Forecasting, Power Tools & Automation** 4.1 Forecasting Techniques – Trend, Moving Average, Regression 4.2 Business Modeling – Profit, Sales, and Budget Analysis 4.3 Power Query – Data Import, Merge, Transform, and Clean 4.4 Power Pivot – Creating Data Models and Basic DAX Functions 4.5 Analysis ToolPak – Descriptive Statistics and Regression Analysis 4.6 Introduction to Macros and VBA Concepts 4.7 Automation of Reports using Macros 4.8 Best Practices in Excel Reporting and Data Protection	07

References:

- Microsoft Excel Data Analysis and Business Modeling – Wayne Winston
- Data Analysis Using Microsoft Excel – Ash Narayan Sah
- Business Analytics with Excel – Conrad Carlberg
- Excel VBA Programming for Dummies – John Walkenbach

Course Outcomes	Programme Outcomes (POs)												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**
CO1	3	3	2	2	2	2	2	2	3	1	1	2	1
CO2	3	3	2	3	3	2	3	3	3	1	1	3	1
CO3	2	3	2	3	3	3	2	2	3	2	2	3	2
CO4	3	3	3	3	3	2	3	3	3	2	2	3	2
CO5	2	3	2	3	3	2	2	3	3	2	2	3	2
CO6	3	2	2	3	3	2	3	3	3	2	2	2	2
CO7	3	3	3	3	3	3	3	2	3	2	2	3	2

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

Justification of Mapping of PO1 with All CO'S

CO1: PO1: Understanding the role of Excel in data management and business decision-making demonstrates a comprehensive grasp of business analysis principles, aligning strongly with PO1's focus on fundamental theories and methodologies.

CO2: PO1: Applying advanced Excel functions and analytical tools to perform complex business computations reflects the practical application of business knowledge and analytical skills, which is highly relevant to PO1.

CO3: PO1: Designing interactive dashboards and charts for effective business data visualization involves applying foundational knowledge to present data meaningfully, moderately contributing to a comprehensive understanding of business analytics as outlined in PO1.

CO4: PO1: Performing forecasting, business modeling, and scenario analysis using Excel tools indicates a strong ability to apply analytical techniques for decision-making, strongly mapping to PO1.

CO5: PO1: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros showcases the application of advanced data handling and process automation, aligning strongly with PO1.

CO6: PO1: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks emphasizes practical analytical skills and decision support, making it strongly related to PO1.

CO7: PO1: Developing automated, insightful reports and dashboards to support data-driven decision-making applies comprehensive Excel and automation knowledge, moderately related to the understanding required in PO1.

Mapping of PO2 with All CO'S

CO1: PO2: Understanding the role of Excel in data management and business decision-making demonstrates practical knowledge and professional skills essential for handling real-world business data, strongly aligning with PO2's focus on procedural expertise.

CO2: PO2: Applying advanced Excel functions and analytical tools to perform complex business computations reflects the application of industry-standard analytical techniques and enhances professional competence, strongly mapping to PO2.

CO3: PO2: Designing interactive dashboards and charts for effective business data visualization involves applying practical skills to communicate insights clearly, which is highly relevant to professional and procedural knowledge outlined in PO2.

CO4: PO2: Performing forecasting, business modeling, and scenario analysis using Excel tools demonstrates the ability to apply professional analytical techniques for decision-making, strongly related to PO2.

CO5: PO2: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros showcases advanced procedural knowledge and professional skill application, strongly aligning with PO2.

CO6: PO2: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks emphasizes practical analytical skills that moderately contribute to professional expertise as required in PO2.

CO7: PO2: Developing automated, insightful reports and dashboards to support data-driven decision-making reflects applied professional knowledge and procedural competency, strongly mapping to PO2.

Mapping of PO3 with All CO'S

CO1: PO3: Understanding the role of Excel in data management and business decision-making supports identifying business opportunities and making informed decisions, moderately aligning with PO3's focus on entrepreneurial mindset and knowledge.

CO2: PO3: Applying advanced Excel functions and analytical tools to perform complex business computations helps evaluate business scenarios and assess risks, moderately contributing to the entrepreneurial knowledge outlined in PO3.

CO3: PO3: Designing interactive dashboards and charts for effective business data visualization aids in presenting business insights clearly, moderately supporting innovation and opportunity identification in an entrepreneurial context.

CO4: PO3: Performing forecasting, business modeling, and scenario analysis using Excel tools directly enables evaluation of market dynamics and risk management, strongly mapping to PO3.

CO5: PO3: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros enhances operational efficiency and supports innovative business processes, moderately related to PO3.

CO6: PO3: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks provides analytical insights to evaluate opportunities and market trends, moderately contributing to entrepreneurial knowledge.

CO7: PO3: Developing automated, insightful reports and dashboards to support data-driven decision-making equips graduates to identify opportunities and make strategic decisions, strongly related to PO3.

Mapping of PO4 with All CO'S

CO1: PO4: Understanding the role of Excel in data management and business decision-making develops foundational technical and analytical skills, supporting problem-solving and decision-making relevant to their field of study.

CO2: PO4: Applying advanced Excel functions and analytical tools to perform complex business computations enhances graduates' technical proficiency and analytical abilities, directly contributing to specialized skills and competencies.

CO3: PO4: Designing interactive dashboards and charts for effective business data visualization fosters effective communication of insights and strengthens technical competencies, aligning with PO4's emphasis on field-specific skills.

CO4: PO4: Performing forecasting, business modeling, and scenario analysis using Excel tools demonstrates advanced problem-solving, analytical skills, and the ability to adapt to changing circumstances, strongly mapping to PO4.

CO5: PO4: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros showcases specialized technical skills and process innovation, contributing to PO4's focus on proficiency and adaptability.

CO6: PO4: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks emphasizes analytical abilities and problem-solving skills relevant to professional competency in the field.

CO7: PO4: Developing automated, insightful reports and dashboards to support data-driven decision-making reflects advanced technical and analytical competencies, effective communication, and adaptability, strongly supporting PO4.

Mapping of PO5 with All CO'S

CO1: PO5: Understanding the role of Excel in data management and business decision-making provides the foundational knowledge needed to apply concepts in practical scenarios and supports problem-solving, moderately aligning with PO5.

CO2: PO5: Applying advanced Excel functions and analytical tools to perform complex business computations enhances analytical reasoning and practical problem-solving skills, strongly contributing to PO5.

CO3: PO5: Designing interactive dashboards and charts for effective business data visualization develops analytical thinking, effective communication of insights, and problem-solving abilities, strongly mapping to PO5.

CO4: PO5: Performing forecasting, business modeling, and scenario analysis using Excel tools demonstrates critical thinking, analytical reasoning, and practical problem-solving, strongly supporting PO5.

CO5: PO5: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot,

and VBA macros showcases the application of technical knowledge to solve real-world problems, strongly aligning with PO5.

CO6: PO5: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks emphasizes analytical reasoning and data-driven problem-solving, strongly related to PO5.

CO7: PO5: Developing automated, insightful reports and dashboards to support data-driven decision-making applies analytical skills, problem-solving, and practical application of knowledge, strongly mapping to PO5.

Mapping of PO6 with All CO'S

CO1: PO6: Understanding the role of Excel in data management and business decision-making helps graduates communicate insights effectively and supports collaboration by providing clear data context.

CO2: PO6: Applying advanced Excel functions and analytical tools to perform complex business computations enhances the ability to present technical information clearly, moderately supporting communication and collaborative problem-solving.

CO3: PO6: Designing interactive dashboards and charts for effective business data visualization develops clear communication of insights and facilitates team collaboration, strongly mapping to PO6.

CO4: PO6: Performing forecasting, business modeling, and scenario analysis using Excel tools supports effective communication of complex analytical results and contributes to team-based decision-making.

CO5: PO6: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros helps communicate processes and results efficiently, moderately related to PO6.

CO6: PO6: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks aids in clearly presenting data-driven insights and supporting collaborative analysis.

CO7: PO6: Developing automated, insightful reports and dashboards to support data-driven decision-making strengthens the ability to communicate findings effectively and collaborate on team projects, strongly supporting PO6.

Mapping of PO7 with All CO'S

CO1: PO7: Understanding the role of Excel in data management and business decision-making provides foundational skills for data collection and preliminary analysis, moderately supporting research-related skills.

CO2: PO7: Applying advanced Excel functions and analytical tools to perform complex business computations enhances the ability to analyze data rigorously and supports research methodology, strongly aligning with PO7.

CO3: PO7: Designing interactive dashboards and charts for effective business data visualization helps present research findings clearly and supports interpretation of data, moderately contributing to PO7.

CO4: PO7: Performing forecasting, business modeling, and scenario analysis using Excel tools develops analytical reasoning and problem-solving for research purposes, strongly mapping to PO7.

CO5: PO7: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros facilitates systematic data handling and reporting, moderately supporting research skills.

CO6: PO7: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks directly supports research data analysis and interpretation, strongly aligning with PO7.

CO7: PO7: Developing automated, insightful reports and dashboards to support data-driven decision-making enables clear reporting of research findings, strongly mapping to PO7.

Mapping of PO8 with All CO'S

CO1: PO8: Understanding the role of Excel in data management and business decision-making encourages self-directed learning and the ability to acquire new knowledge, moderately supporting PO8.

CO2: PO8: Applying advanced Excel functions and analytical tools to perform complex business computations fosters independent skill development and adaptability, strongly mapping to PO8.

CO3: PO8: Designing interactive dashboards and charts for effective business data visualization helps learners develop new technical skills and adapt to changing reporting demands, moderately contributing to PO8.

CO4: PO8: Performing forecasting, business modeling, and scenario analysis using Excel tools cultivates self-directed analytical learning and goal-oriented problem-solving, strongly related to PO8.

CO5: PO8: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros encourages independent learning of advanced tools and procedural skills, strongly supporting PO8.

CO6: PO8: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks promotes self-directed development of analytical competencies, moderately related to PO8.

CO7: PO8: Developing automated, insightful reports and dashboards to support data-driven decision-making fosters independent learning, adaptability, and skill acquisition, strongly aligning with PO8.

Mapping of PO9 with All CO'S

CO1: PO9: Understanding the role of Excel in data management and business decision-making strengthens foundational digital and technological skills, strongly aligning with PO9.

CO2: PO9: Applying advanced Excel functions and analytical tools to perform complex business computations develops proficiency in ICT tools and software-based data analysis, strongly supporting PO9.

CO3: PO9: Designing interactive dashboards and charts for effective business data visualization enhances technological skills and the ability to use software to present information effectively, strongly contributing to PO9.

CO4: PO9: Performing forecasting, business modeling, and scenario analysis using Excel tools cultivates analytical and ICT competencies, strongly mapping to PO9.

CO5: PO9: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot,

and VBA macros strengthens technical skills and proficiency in digital tools, strongly aligning with PO9.

CO6: PO9: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks enhances software-based data analysis skills, strongly contributing to PO9.

CO7: PO9: Developing automated, insightful reports and dashboards to support data-driven decision-making reflects advanced digital proficiency and technology-enabled analytical capabilities, strongly supporting PO9.

Mapping of PO10 with All CO'S

CO1: PO10: Understanding the role of Excel in data management and business decision-making has limited direct impact on multicultural competence and empathy, partially supporting PO10.

CO2: PO10: Applying advanced Excel functions and analytical tools to perform complex business computations primarily develops technical skills, with minimal contribution to multicultural competence and inclusive spirit.

CO3: PO10: Designing interactive dashboards and charts for effective business data visualization can support collaborative work and communication across diverse teams, moderately relating to PO10.

CO4: PO10: Performing forecasting, business modeling, and scenario analysis using Excel tools involves teamwork and sharing insights, moderately contributing to understanding diverse perspectives in a professional context.

CO5: PO10: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros can support collaborative efficiency and inclusivity in team environments, moderately mapping to PO10.

CO6: PO10: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks supports sharing and interpreting data in group settings, moderately contributing to multicultural competence.

CO7: PO10: Developing automated, insightful reports and dashboards to support data-driven decision-making enables clearer communication and collaboration across diverse teams, moderately supporting PO10.

Mapping of PO11 with All CO'S

CO1: PO11: Understanding the role of Excel in data management and business decision-making has minimal direct impact on value inculcation and environmental awareness, partially supporting PO11.

CO2: PO11: Applying advanced Excel functions and analytical tools to perform complex business computations primarily develops technical skills, with limited contribution to ethical or environmental values.

CO3: PO11: Designing interactive dashboards and charts for effective business data visualization can aid in presenting sustainability or ethical data effectively, moderately contributing to PO11.

CO4: PO11: Performing forecasting, business modeling, and scenario analysis using Excel tools can

support decision-making in ethical or sustainable contexts, moderately aligning with PO11.

CO5: PO11: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros can facilitate efficient reporting of sustainability and ethical practices, moderately mapping to PO11.

CO6: PO11: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks supports analyzing data related to ethical practices or environmental impact, moderately contributing to PO11.

CO7: PO11: Developing automated, insightful reports and dashboards to support data-driven decision-making enables monitoring and reporting of ethical and sustainability-related metrics, moderately supporting PO11.

Mapping of PO12 with All CO'S

CO1: PO12: Understanding the role of Excel in data management and business decision-making supports independent application of knowledge and encourages responsibility in managing data-related tasks.

CO2: PO12: Applying advanced Excel functions and analytical tools to perform complex business computations enhances graduates' ability to work autonomously and take accountability for analytical results.

CO3: PO12: Designing interactive dashboards and charts for effective business data visualization develops skills for independently presenting insights and managing information responsibly.

CO4: PO12: Performing forecasting, business modeling, and scenario analysis using Excel tools demonstrates independent analytical decision-making and accountability for scenario outcomes.

CO5: PO12: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros reflects autonomy in managing processes and responsibility in ensuring accuracy and efficiency.

CO6: PO12: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks supports independent data analysis and accountability for deriving valid insights.

CO7: PO12: Developing automated, insightful reports and dashboards to support data-driven decision-making fosters autonomous working, responsibility in reporting, and accountability for results.

Mapping of PO13 with All CO'S

CO1: PO13: Understanding the role of Excel in data management and business decision-making has minimal direct impact on community engagement and service, partially supporting PO13.

CO2: PO13: Applying advanced Excel functions and analytical tools to perform complex business computations primarily develops technical skills, with limited contribution to community service activities.

CO3: PO13: Designing interactive dashboards and charts for effective business data visualization can assist in sharing insights that support community projects, moderately contributing to PO13.

CO4: PO13: Performing forecasting, business modeling, and scenario analysis using Excel tools can help in planning community initiatives and analyzing their impact, moderately aligning with PO13.

CO5: PO13: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros supports efficient reporting for community-focused projects, moderately mapping to PO13.

CO6: PO13: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks enables assessment of data related to community programs, moderately contributing to PO13.

CO7: PO13: Developing automated, insightful reports and dashboards to support data-driven decision-making facilitates monitoring and communication for community engagement initiatives, moderately supporting PO13.

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

Name of the Programme	**:** For T.Y.UG Sem -VI
Program Code	**:** USCOS
Class	**:** T.Y.U.G
Semester	**: VI**
Course Type	**:** Minor for TY UG (PR)
Course Name	**:** Lab Course Based On COS-361-MN (D)
Course Code	**:** COS-362-MN (D)
No. of Lectures	**: 60**
No. of Credits	**: 02**

Prerequisites:

- Basic knowledge of computers and Microsoft Excel.
- Understanding of basic business concepts such as sales, cost, and profit.

Course Objectives:

1: To provide knowledge of Microsoft Excel tools and techniques used for business analysis and decision-making.

2: To enhance analytical skills through the application of advanced formulas, functions, and data manipulation techniques in Excel.

3: To enable students to summarize, visualize, and interpret business data effectively using charts and dashboards.

4: To introduce forecasting, scenario analysis, and data modeling concepts for informed business decision-making

5: To enable students to use Power Query, Power Pivot, and VBA for advanced data analysis and automating business processes..

6: To familiarize students with descriptive statistics, regression analysis, and other analytical techniques using Analysis ToolPak.

7: To empower students to design automated reports and dashboards to support data-driven business decisions.

Course Outcomes:

CO1: Demonstrate proficiency in Microsoft Excel by applying basic and advanced formulas, functions, and formatting techniques for business problem-solving.

CO2: Analyze and manipulate large datasets using Excel tools such as sorting, filtering, conditional formatting, and pivot tables to extract actionable insights.

CO3: Create dynamic and interactive dashboards, charts, and visualizations to summarize and communicate business information effectively.
CO4: Apply forecasting techniques, scenario analysis, and data modeling in Excel to support informed business decision-making.
CO5: Utilize Power Query and Power Pivot to import, transform, merge, and model data for comprehensive business analysis.
CO6: Implement automation of repetitive tasks and report generation using Macros and VBA programming in Excel.
CO7: Design end-to-end automated reports and dashboards that integrate Excel, Power Tools, and VBA to support data-driven business decisions.

Sr. No.	Assignment Name	No. of Practical's
1.	Excel Interface & Data Entry	1
2.	Data Cleaning	1
3.	Data Validation & Conditional Formatting	1
4.	Logical Functions	1
5.	Lookup & Reference Functions	1
6.	Text & Date Functions	1
7.	Statistical & Financial Functions	1
8	Pivot Tables & Pivot Charts	1
9.	Charts & Dashboard Design	1
10.	Forecasting & Business Modeling	1
11.	Power Pivot	1
12.	Analysis ToolPak	1
13.	Macros & VBA	1

Mapping of PO's With CO's

Course Outcomes	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	2	2	2	2	2	2	3	1	1	2	1
CO2	3	3	2	3	3	2	3	3	3	1	1	3	1
CO3	2	3	2	3	3	3	2	2	3	2	2	3	2
CO4	3	3	3	3	3	2	3	3	3	2	2	3	2
CO5	2	3	2	3	3	2	2	3	3	2	2	3	2
CO6	3	2	2	3	3	2	3	3	3	2	2	2	2
CO7	3	3	3	3	3	3	3	2	3	2	2	3	2

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

Justification of Mapping of PO1 with All CO'S

CO1: PO1: Understanding the role of Excel in data management and business decision-making demonstrates a comprehensive grasp of business analysis principles, aligning strongly with PO1's focus on fundamental theories and methodologies.

CO2: PO1: Applying advanced Excel functions and analytical tools to perform complex business computations reflects the practical application of business knowledge and analytical skills, which is highly relevant to PO1.

CO3: PO1: Designing interactive dashboards and charts for effective business data visualization involves applying foundational knowledge to present data meaningfully, moderately contributing to a comprehensive understanding of business analytics as outlined in PO1.

CO4: PO1: Performing forecasting, business modeling, and scenario analysis using Excel tools indicates a strong ability to apply analytical techniques for decision-making, strongly mapping to PO1.

CO5: PO1: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros showcases the application of advanced data handling and process automation, aligning strongly with PO1.

CO6: PO1: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks emphasizes practical analytical skills and decision support, making it strongly related to PO1.

CO7: PO1: Developing automated, insightful reports and dashboards to support data-driven decision-making applies comprehensive Excel and automation knowledge, moderately related to the understanding required in PO1.

Mapping of PO2 with All CO'S

CO1: PO2: Understanding the role of Excel in data management and business decision-making demonstrates practical knowledge and professional skills essential for handling real-world business data, strongly aligning with PO2's focus on procedural expertise.

CO2: PO2: Applying advanced Excel functions and analytical tools to perform complex business computations reflects the application of industry-standard analytical techniques and enhances professional competence, strongly mapping to PO2.

CO3: PO2: Designing interactive dashboards and charts for effective business data visualization involves applying practical skills to communicate insights clearly, which is highly relevant to professional and procedural knowledge outlined in PO2.

CO4: PO2: Performing forecasting, business modeling, and scenario analysis using Excel tools demonstrates the ability to apply professional analytical techniques for decision-making, strongly related to PO2.

CO5: PO2: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros showcases advanced procedural knowledge and professional skill application, strongly aligning with PO2.

CO6: PO2: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business

analytics tasks emphasizes practical analytical skills that moderately contribute to professional expertise as required in PO2.

CO7: PO2: Developing automated, insightful reports and dashboards to support data-driven decision-making reflects applied professional knowledge and procedural competency, strongly mapping to PO2.

Mapping of PO3 with All CO'S

CO1: PO3: Understanding the role of Excel in data management and business decision-making supports identifying business opportunities and making informed decisions, moderately aligning with PO3's focus on entrepreneurial mindset and knowledge.

CO2: PO3: Applying advanced Excel functions and analytical tools to perform complex business computations helps evaluate business scenarios and assess risks, moderately contributing to the entrepreneurial knowledge outlined in PO3.

CO3: PO3: Designing interactive dashboards and charts for effective business data visualization aids in presenting business insights clearly, moderately supporting innovation and opportunity identification in an entrepreneurial context.

CO4: PO3: Performing forecasting, business modeling, and scenario analysis using Excel tools directly enables evaluation of market dynamics and risk management, strongly mapping to PO3.

CO5: PO3: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros enhances operational efficiency and supports innovative business processes, moderately related to PO3.

CO6: PO3: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks provides analytical insights to evaluate opportunities and market trends, moderately contributing to entrepreneurial knowledge.

CO7: PO3: Developing automated, insightful reports and dashboards to support data-driven decision-making equips graduates to identify opportunities and make strategic decisions, strongly related to PO3.

Mapping of PO4 with All CO'S

CO1: PO4: Understanding the role of Excel in data management and business decision-making develops foundational technical and analytical skills, supporting problem-solving and decision-making relevant to their field of study.

CO2: PO4: Applying advanced Excel functions and analytical tools to perform complex business computations enhances graduates' technical proficiency and analytical abilities, directly contributing to specialized skills and competencies.

CO3: PO4: Designing interactive dashboards and charts for effective business data visualization fosters effective communication of insights and strengthens technical competencies, aligning with PO4's emphasis on field-specific skills.

CO4: PO4: Performing forecasting, business modeling, and scenario analysis using Excel tools demonstrates advanced problem-solving, analytical skills, and the ability to adapt to changing

circumstances, strongly mapping to PO4.

CO5: PO4: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros showcases specialized technical skills and process innovation, contributing to PO4's focus on proficiency and adaptability.

CO6: PO4: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks emphasizes analytical abilities and problem-solving skills relevant to professional competency in the field.

CO7: PO4: Developing automated, insightful reports and dashboards to support data-driven decision-making reflects advanced technical and analytical competencies, effective communication, and adaptability, strongly supporting PO4.

Mapping of PO5 with All CO'S

CO1: PO5: Understanding the role of Excel in data management and business decision-making provides the foundational knowledge needed to apply concepts in practical scenarios and supports problem-solving, moderately aligning with PO5.

CO2: PO5: Applying advanced Excel functions and analytical tools to perform complex business computations enhances analytical reasoning and practical problem-solving skills, strongly contributing to PO5.

CO3: PO5: Designing interactive dashboards and charts for effective business data visualization develops analytical thinking, effective communication of insights, and problem-solving abilities, strongly mapping to PO5.

CO4: PO5: Performing forecasting, business modeling, and scenario analysis using Excel tools demonstrates critical thinking, analytical reasoning, and practical problem-solving, strongly supporting PO5.

CO5: PO5: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros showcases the application of technical knowledge to solve real-world problems, strongly aligning with PO5.

CO6: PO5: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks emphasizes analytical reasoning and data-driven problem-solving, strongly related to PO5.

CO7: PO5: Developing automated, insightful reports and dashboards to support data-driven decision-making applies analytical skills, problem-solving, and practical application of knowledge, strongly mapping to PO5.

Mapping of PO6 with All CO'S

CO1: PO6: Understanding the role of Excel in data management and business decision-making helps graduates communicate insights effectively and supports collaboration by providing clear data context.

CO2: PO6: Applying advanced Excel functions and analytical tools to perform complex business computations enhances the ability to present technical information clearly, moderately supporting

communication and collaborative problem-solving.

CO3: PO6: Designing interactive dashboards and charts for effective business data visualization develops clear communication of insights and facilitates team collaboration, strongly mapping to PO6.

CO4: PO6: Performing forecasting, business modeling, and scenario analysis using Excel tools supports effective communication of complex analytical results and contributes to team-based decision-making.

CO5: PO6: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros helps communicate processes and results efficiently, moderately related to PO6.

CO6: PO6: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks aids in clearly presenting data-driven insights and supporting collaborative analysis.

CO7: PO6: Developing automated, insightful reports and dashboards to support data-driven decision-making strengthens the ability to communicate findings effectively and collaborate on team projects, strongly supporting PO6.

Mapping of PO7 with All CO'S

CO1: PO7: Understanding the role of Excel in data management and business decision-making provides foundational skills for data collection and preliminary analysis, moderately supporting research-related skills.

CO2: PO7: Applying advanced Excel functions and analytical tools to perform complex business computations enhances the ability to analyze data rigorously and supports research methodology, strongly aligning with PO7.

CO3: PO7: Designing interactive dashboards and charts for effective business data visualization helps present research findings clearly and supports interpretation of data, moderately contributing to PO7.

CO4: PO7: Performing forecasting, business modeling, and scenario analysis using Excel tools develops analytical reasoning and problem-solving for research purposes, strongly mapping to PO7.

CO5: PO7: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros facilitates systematic data handling and reporting, moderately supporting research skills.

CO6: PO7: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks directly supports research data analysis and interpretation, strongly aligning with PO7.

CO7: PO7: Developing automated, insightful reports and dashboards to support data-driven decision-making enables clear reporting of research findings, strongly mapping to PO7.

Mapping of PO8 with All CO'S

CO1: PO8: Understanding the role of Excel in data management and business decision-making encourages self-directed learning and the ability to acquire new knowledge, moderately supporting PO8.

CO2: PO8: Applying advanced Excel functions and analytical tools to perform complex business computations fosters independent skill development and adaptability, strongly mapping to PO8.

CO3: PO8: Designing interactive dashboards and charts for effective business data visualization helps learners develop new technical skills and adapt to changing reporting demands, moderately contributing to PO8.

CO4: PO8: Performing forecasting, business modeling, and scenario analysis using Excel tools cultivates self-directed analytical learning and goal-oriented problem-solving, strongly related to PO8.

CO5: PO8: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros encourages independent learning of advanced tools and procedural skills, strongly supporting PO8.

CO6: PO8: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks promotes self-directed development of analytical competencies, moderately related to PO8.

CO7: PO8: Developing automated, insightful reports and dashboards to support data-driven decision-making fosters independent learning, adaptability, and skill acquisition, strongly aligning with PO8.

Mapping of PO9 with All CO'S

CO1: PO9: Understanding the role of Excel in data management and business decision-making strengthens foundational digital and technological skills, strongly aligning with PO9.

CO2: PO9: Applying advanced Excel functions and analytical tools to perform complex business computations develops proficiency in ICT tools and software-based data analysis, strongly supporting PO9.

CO3: PO9: Designing interactive dashboards and charts for effective business data visualization enhances technological skills and the ability to use software to present information effectively, strongly contributing to PO9.

CO4: PO9: Performing forecasting, business modeling, and scenario analysis using Excel tools cultivates analytical and ICT competencies, strongly mapping to PO9.

CO5: PO9: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros strengthens technical skills and proficiency in digital tools, strongly aligning with PO9.

CO6: PO9: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks enhances software-based data analysis skills, strongly contributing to PO9.

CO7: PO9: Developing automated, insightful reports and dashboards to support data-driven decision-making reflects advanced digital proficiency and technology-enabled analytical capabilities, strongly supporting PO9.

Mapping of PO10 with All CO'S

CO1: PO10: Understanding the role of Excel in data management and business decision-making has limited direct impact on multicultural competence and empathy, partially supporting PO10.

CO2: PO10: Applying advanced Excel functions and analytical tools to perform complex business computations primarily develops technical skills, with minimal contribution to multicultural competence and inclusive spirit.

CO3: PO10: Designing interactive dashboards and charts for effective business data visualization can support collaborative work and communication across diverse teams, moderately relating to PO10.

CO4: PO10: Performing forecasting, business modeling, and scenario analysis using Excel tools involves teamwork and sharing insights, moderately contributing to understanding diverse perspectives in a professional context.

CO5: PO10: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros can support collaborative efficiency and inclusivity in team environments, moderately mapping to PO10.

CO6: PO10: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks supports sharing and interpreting data in group settings, moderately contributing to multicultural competence.

CO7: PO10: Developing automated, insightful reports and dashboards to support data-driven decision-making enables clearer communication and collaboration across diverse teams, moderately supporting PO10.

Mapping of PO11 with All CO'S

CO1: PO11: Understanding the role of Excel in data management and business decision-making has minimal direct impact on value inculcation and environmental awareness, partially supporting PO11.

CO2: PO11: Applying advanced Excel functions and analytical tools to perform complex business computations primarily develops technical skills, with limited contribution to ethical or environmental values.

CO3: PO11: Designing interactive dashboards and charts for effective business data visualization can aid in presenting sustainability or ethical data effectively, moderately contributing to PO11.

CO4: PO11: Performing forecasting, business modeling, and scenario analysis using Excel tools can support decision-making in ethical or sustainable contexts, moderately aligning with PO11.

CO5: PO11: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros can facilitate efficient reporting of sustainability and ethical practices, moderately mapping to PO11.

CO6: PO11: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks supports analyzing data related to ethical practices or environmental impact, moderately contributing to PO11.

CO7: PO11: Developing automated, insightful reports and dashboards to support data-driven decision-making enables monitoring and reporting of ethical and sustainability-related metrics, moderately supporting PO11.

Mapping of PO12 with All CO'S

CO1: PO12: Understanding the role of Excel in data management and business decision-making supports independent application of knowledge and encourages responsibility in managing data-related tasks.

CO2: PO12: Applying advanced Excel functions and analytical tools to perform complex business computations enhances graduates' ability to work autonomously and take accountability for analytical results.

CO3: PO12: Designing interactive dashboards and charts for effective business data visualization develops skills for independently presenting insights and managing information responsibly.

CO4: PO12: Performing forecasting, business modeling, and scenario analysis using Excel tools demonstrates independent analytical decision-making and accountability for scenario outcomes.

CO5: PO12: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros reflects autonomy in managing processes and responsibility in ensuring accuracy and efficiency.

CO6: PO12: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks supports independent data analysis and accountability for deriving valid insights.

CO7: PO12: Developing automated, insightful reports and dashboards to support data-driven decision-making fosters autonomous working, responsibility in reporting, and accountability for results.

Mapping of PO13 with All CO'S

CO1: PO13: Understanding the role of Excel in data management and business decision-making has minimal direct impact on community engagement and service, partially supporting PO13.

CO2: PO13: Applying advanced Excel functions and analytical tools to perform complex business computations primarily develops technical skills, with limited contribution to community service activities.

CO3: PO13: Designing interactive dashboards and charts for effective business data visualization can assist in sharing insights that support community projects, moderately contributing to PO13.

CO4: PO13: Performing forecasting, business modeling, and scenario analysis using Excel tools can help in planning community initiatives and analyzing their impact, moderately aligning with PO13.

CO5: PO13: Demonstrating the ability to automate reports and workflows using Power Query, Power Pivot, and VBA macros supports efficient reporting for community-focused projects, moderately mapping to PO13.

CO6: PO13: Using Analysis ToolPak for descriptive statistics, regression analysis, and other business analytics tasks enables assessment of data related to community programs, moderately contributing to PO13.

CO7: PO13: Developing automated, insightful reports and dashboards to support data-driven decision-making facilitates monitoring and communication for community engagement initiatives, moderately supporting PO13.