

Affiliated to  
University of Mumbai



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

**Bachelor of Science (Computer Science) (B.Sc. CS)  
Programme Four Year Integrated Programme-  
Eight Semesters**

***Course Structure***

**Under Choice Based Credit System (CBCS)**

**To be implemented from Academic Year 2023-2024  
Progressively**

### **Preamble**

The restructured curriculum for the First year computer science is systematically designed considering the National Education Policy (NEP) along with the Autonomy constraints.

The rise of Information and Communication Technology (ICT) has profoundly affected modern society. Increasing applications of computers in almost all areas of human endeavor has led to vibrant industries with concurrent rapid change in technology.

As the computing field advances at a rapid pace, the students must possess a solid foundation that allows and encourages them to maintain relevant skills as the field evolves. Specific languages and technology platforms change over time. Thus students must continue to learn and adapt their skills throughout their careers. To develop this ability, students will be exposed to multiple programming languages, tools, paradigms and technologies as well as the fundamental underlying principles throughout this programme.

The core philosophy of this programme is to –

- Form strong foundations of Computer Science
- Nurture programming, analytical & design skills for the real world problems.
- Introduce emerging trends to the students in a gradual way.
- Groom the students for the challenges of ICT industry

The students these days not only aspire for a career in the industry but also look for research opportunities. The main aim of this programme is to deliver a modern curriculum that will equip graduates with strong theoretical and practical backgrounds to enable them to excel in the workplace and to be lifelong learners. Not only does it prepare the students for a career in the Software industry, it also motivates them towards further studies and research opportunities. In the first year i.e. for semester I & II, the basic foundation of important skills required for software development is laid. The syllabus proposes to have two major courses of Computer Science and one minor course of Applied Mathematics. All major subjects are to have theory as well as practical tracks. While the Computer Science courses will form fundamental skills for solving computational problems, the Applied Mathematics allows students to develop the use of quantitative methods in thinking about and solving problems.

Courses on Value Education plays an important role in helping individuals carry out social, moral, and democratic obligations. The main purpose of Skill Enhancement courses is to provide students with life-skills in the hands-on mode to increase their employability. The purpose of Ability Enhancement Course is to introduce students to the theory, fundamentals and tools of communication and to develop vital communication skills in them which should be integral to personal, social and professional interactions. Vocational and Skill Enhancement Courses like web designing and Linux focuses on developing technical skills in Computer Science. Indian Knowledge System courses focuses on the evolution of computer and the computing environment in technology. Open Elective courses are offered to construct basic diluted structure of computer science.

We sincerely believe that any student enrolling in this programme will get very strong foundation and exposure to basics, advanced and emerging trends of the subject.

We wholeheartedly thank all experts who shared their valuable feedbacks and suggestions in order to improvise the contents; we have sincerely attempted to incorporate each of them. We further thank Chairperson and members of Board of Studies for their confidence in us.

Special thanks to Department of Computer Science and colleagues from various colleges, who volunteered or have indirectly, helped designing certain specialized courses and the syllabus as a whole.

Syllabus for F.Y.B.Sc. Computer Science : Implementation Year 2023-24

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

Name of Programme	<b>BACHELOR OF SCIENCE (B.Sc.)(Computer Science)</b>
Level	Under Graduate
No of Semesters	06
Year of Implementation	<b>2023-24</b>
Programme Specific Outcomes (PSO)	<ol style="list-style-type: none"> <li>1. To formulate, model, design solutions, procedure and to use software tools to solve real world problems.</li> <li>2. To design and develop computer programs/computer - based systems in the areas such as networking, web design, security, cloud computing, IoT, data science and other emerging technologies.</li> <li>3. To familiarize with the modern-day trends in industry and research based settings and thereby innovate novel solutions to existing problems.</li> <li>4. To apply concepts, principles, and theories relating to computer science to new situations.</li> <li>5. To use current techniques, skills, and tools necessary for computing practice</li> <li>6. To apply standard Software Engineering practices and strategies in real-time software project development</li> <li>7. To pursue higher studies of specialization and to take up technical employment.</li> <li>8. To work independently or collaboratively as an effective team member on a substantial software project.</li> <li>9. To communicate and present their work effectively and coherently.</li> <li>10. To display an ethical code of conduct in usage of Internet and Cyber systems.</li> <li>11. To engage in independent and life-long learning in the background of rapid changing IT industry</li> </ol>



<p>Relevance of PSOs to the local, regional, national, and global developmental needs</p>	<p>The revised and restructured curriculum for the Three-year integrated course is systematically designed considering the National Education Policy (NEP) along with the Autonomy constraints. The focus is on current industry needs in terms of skills sets demanded under the new technological environment. It also endeavors to align the programme structure and course curriculum with student aspirations and corporate expectations. The curriculum is more contextual, industryfriendly and suitable to cater the needs of society and nation in the present day context.</p> <p>As the world is heading towards digitalization, the syllabus is framed by concentrating on such needs. With the help of basic programming skills and designing technique, a student is able to make small workable projects which can be beneficial for local vendors. To make these projects strong, various concepts of project management, database management are involved.</p> <p>Various industries need IT support at local or across the country. Students having the skills of computers are able to sustain in the IT industry at various locations.</p> <p>Development in thought processes can lead one in a research area to contribute to an upcoming trend. Students can become entrepreneurs since the techniques of management and entrepreneurship are taught to them.</p> <p>Due to the learning of cyber safety, ethical hacking, students can become ethical hackers where students can contribute to national security. Students can make community awareness due to learning about cyber safety.</p> <p>Continuous growth in trends requires students updated which will help them mercurial. This will help in sustaining the IT industry and become employable.</p>
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**Evaluation Scheme****For Theory Course:**

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

Evaluation for the course will be of 100 marks conducted in a 60: 40 pattern. 60 marks will be for semester end examination and 40 marks will be for internal evaluation. At the end of semester, total marks obtained will be converted to 50 marks as 2 credits are equivalent to 50 marks.-

**A) Internal Assessment: 40 % (40 Marks)**

Sr. No.	Particulars	Marks
01	<b>Mid-Term Class Test</b> It should be conducted using any <b>learning management system</b> such as <b>Moodle</b> (Modular object-oriented dynamic learning environment) Question Paper Pattern for Periodical Class Test/ Online Examination Duration: 40 Minutes Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)	<b>20</b>
02	<b>Assignment/ Case study/ Presentations</b>	<b>10</b>
03	<b>Attendance</b>	<b>05</b>
04	<b>Behavior</b>	<b>05</b>

**B) Semester End Examination: 60% (60 Marks)*****Question Paper Pattern***

Maximum Marks: 60  
Questions to be set: 04  
Duration: 2 Hours

Question No.	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	All Units	Objective Based	15

### Evaluation Scheme

#### For Practical Course:

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

Evaluation for the course will be of 100 marks conducted in a 60: 40 pattern. 60 marks will be for semester end examination and 40 marks will be for internal evaluation. At the end of semester, total marks obtained will be converted to 50 marks as 2 credits are equivalent to 50 marks.

#### A. Internal Examination: 40 Marks

Sr. No	Criterion	Marks
1	Journals containing minimum 20 practical's which are timely completed with desired output	30
2	Attendance & Practical Performance	10

#### B. Semester End Examination: 60 Marks

**Duration: 2 hours**

Sr. No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	30
2	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
3	Viva	05

### Standard of Passing

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

### Performance Grading:

#### Letter Grades and Grade Points

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

**B.Sc.(Computer Science) Programme****F.Y.B.Sc.(Computer****Under Choice Based Credit System(CBCS) Course  
Structure (Autonomous)****(To be implemented from Academic Year- 2023-24)**

No. of Courses	Semester I	Cred its	No. of Courses	Semester II	Cred its
	<b>Department Specific Courses (DSC)</b>			<b>Department Specific Courses (DSC)</b>	
	<b>Major</b>			<b>Major</b>	
USCS101	Digital Systems & Architecture	<b>02</b>	USCS201	Database Systems	<b>02</b>
USCS102	Fundamentals of Programming Paradigm	<b>02</b>	USCS202	Programming with C++	<b>02</b>
USCS103	Computer Science Practical 1	<b>02</b>	USCS203	Computer Science Practical 2	<b>02</b>
	<b>Minor</b>			<b>Minor</b>	
USCS104	Applied Mathematics - I	<b>02</b>	USCS204	Applied Mathematics - II	<b>02</b>
USCS105	Statistics using R practical	<b>02</b>	USCS205	Data Structures	<b>02</b>
			USCS206	Minor Practical	<b>02</b>
	<b>Generic / Open Elective</b>			<b>Generic / Open Elective</b>	
	Any one course from the List given below	<b>02</b>		Any one course from the List given below	<b>02</b>
	<b>Indian Knowledge System (IKS)</b>				
USCS106	Evolution of Computing in India	<b>02</b>			
	<b>Vocational Skill Course (VSC)</b>			<b>Skill Enhancement Course (SEC)</b>	
USCS107	Programming with Python Practical	<b>02</b>	USCS207	LINUX Practical	<b>02</b>
	<b>Ability Enhancement Course (AEC)</b>			<b>Ability Enhancement Course (AEC)</b>	
USCS108	English (Soft Skill Development -I)	<b>02</b>	USCS208	Content Writing	<b>02</b>

<i>Value Education Course (VEC)</i>			<i>Value Education Course (VEC)</i>		
USCS109	Green Computing - I	02	USCS209	Green Computing - II	02
<i>Co-Curricular</i>			<i>Co-Curricular</i>		
USCS110	Any one course from the List given below	02	USCS210	Any one course from the List given below	02
<b>Total Credits</b>		<b>22</b>	<b>Total Credits</b>		<b>22</b>

**Table 1: Open Electives for Science, IT, BT, CS Faculty**

<i>Open Elective Course</i>		<i>Open Elective Course</i>	
USOE101	Astronomy for Beginners	USOE201	Observational Astronomy
USOE102	Discrete Mathematics	USOE202	Numerical Methods
USOE103	Google workspace and multimedia applications	USOE203	Basic computer system
USOE104	Health and Hygiene - I	USOE204	Health and Hygiene - II
USOE105	Health and Nutrition	USOE205	Health and Nutrition
USOE106	Social media marketing	USOE206	Introduction to Bioinformatics
USOE107	Plants in Human Welfare - I	USOE207	Plants in Human Welfare – II
		USOE208	Advance Excel
		USOE209	Food Science

**Table 2: Co-Curricular Courses**

<i>Semester I Co-Curricular Courses</i>		<i>Semester II Co-Curricular Courses</i>	
1	<i>National Social Service (NSS)</i>	1	<i>National Social Service (NSS)</i>
2	<i>National Cadet Corps (NCC)</i>	2	<i>National Cadet Corps (NCC)</i>
3	<i>Sports</i>	3	<i>Sports</i>
4	<i>Cultural</i>	4	<i>Cultural</i>
5	<i>Yoga</i>	5	<i>Yoga</i>
6	<i>Life Long Learning</i>	6	<i>Life Long Learning</i>
7	<i>Research (Shodhavedh – Avishkar)</i>	7	<i>Research (Shodhavedh – Avishkar)</i>
8	<i>Publications</i>	8	<i>Publications</i>
9	<i>Marathi Vidnyan Parishad</i>	9	<i>Marathi Vidnyan Parishad</i>
10	<i>Nature Club</i>	10	<i>Nature Club</i>
11	<i>Science Association</i>	11	<i>Science Association</i>
12	<i>Astronomy Club</i>	12	<i>Astronomy Club</i>
13	<i>Women Development Cell</i>	13	<i>Women Development Cell</i>
14	<i>Literary Association</i>	14	<i>Literary Association</i>
15	<i>Sahyadri Mountaineering Club</i>	15	<i>Sahyadri Mountaineering Club</i>
16	<i>Film Club</i>	16	<i>Film Club</i>
17	<i>Infosys Course</i>	17	<i>Infosys Course</i>
18	<i>Career katta</i>	18	<i>Career katta</i>

**Semester I**  
**Syllabus of Courses of B.Sc. Computer Science**  
**Programme at Semester I**  
**with Effect from the Academic Year 2023-2024**  
**Department Specific Courses (DSC)**  
**Major Course**

<b>Name of the Course</b>	<b>Digital Systems &amp; Architecture</b>
Course Code	USCS101
Class	FYBSC
Semester	I
No of Credits	2
Nature	Theory
Type	Major
Employability/ entrepreneurship/ skill development	This course introduces basic components used in computer system. Various number systems such as binary, hexadecimal and octal are introduced which will help learners how data gets stored in computer system and transmitted through computer system. Logic gates, combinational and sequential circuits are introduced in practical. Hardware concepts are kept so that learners will able to understand mechanism of hardware. This course will help those students who are interested in hardware and networking.

**Digital Systems & Architecture**  
**Modules at a Glance**

<b>Sr. No.</b>	<b>Modules</b>	<b>No. of Lectures</b>
1	Fundamentals of Digital Logic ,Computer System	10
2	Memory System Organization, Processor Organization	10
3	Control Unit, Fundamentals of Advanced Computer Architecture	10
<b>Total</b>		<b>30</b>

**Course Outcomes**

The learner will be able to

1. To have an understanding of Digital Systems and operation of a digital computer.
2. To learn different architectures & organizations of memory systems, processor organization and control unit.
3. To understand the working principles of multiprocessor and parallel organization's as advanced computer architectures

Sr. No.	Modules / Units
1	<p><b>Fundamentals of Digital Logic ,Computer System (10 Lectures)</b></p> <p>Boolean algebra, Logic Gates, Simplification of Logic Circuits: Algebraic Simplification, Combinational Circuits: Adders, Mux, De-Mux, Sequential Circuits: Flip- Flops (SR, JK &amp; D), Counters: synchronous and asynchronous Counter.</p> <p>Comparison of Computer Organization &amp; Architecture, Computer Components and Functions, Interconnection Structures. Bus Interconnections, Input / Output: I/O Module, Interrupt Driven I/O, Direct Memory Access, Number System: Binary, Decimal, Octal, Hexadecimal.</p>
2	<p><b>Memory System Organization, Processor Organization (10 Lectures)</b></p> <p>Classification and design parameters, Memory Hierarchy, Internal Memory: RAM, SRAM and DRAM, Cache Memory: Design Principles, Virtual Memory, External Memory: Magnetic Discs, Optical Memory, Flash Memories.</p> <p>Instruction Formats, Instruction Sets, Addressing Modes, Addressing Modes Examples with Assembly Language [8085/8086 CPU], Register Organization, Basic Microprocessor operations: Data Transfer (Register / Memory) Operations, Arithmetic &amp; Logical Operations, Introduction to RISC and CISC Architecture, Micro-Operations,</p>
3	<p><b>Control Unit, Fundamentals of Advanced Computer Architecture (10 Lectures)</b></p> <p>Processor Control, Hardwired Implementation, Micro-programmed Control. Parallel Architecture: Classification of Parallel Systems, Flynn's Taxonomy, Array Processors, Clusters, and NUMA Computers. Multiprocessor Systems: Structure &amp; Interconnection Networks, Multi-Core Computers: Introduction, Organization and Performance.</p>

### **Learning Resources recommended**

#### **Textbook(s):**

1. M. Mano, Computer System Architecture 3rd edition, Pearson
2. Carl Hamacher et al., Computer Organization and Embedded Systems, 6 ed., McGraw-Hill 2012
3. R P Jain, Modern Digital Electronics, Tata McGraw Hill Education Pvt. Ltd. , 4th Edition, 2010

#### **Additional Reference(s):**

1. William Stallings (2010), Computer Organization and Architecture- designing for performance, 8th edition, Prentice Hall, New Jersey.
2. Andrew S. Tanenbaum (2006), Structured Computer Organization, 5th edition, Pearson Education Inc,
3. John P. Hayes (1998), Computer Architecture and Organization, 3rd edition, Tata McGrawHill



***Syllabus of Courses of B.Sc. Computer Science  
Programme at Semester I  
with Effect from the Academic Year 2023-2024  
Department Specific Courses (DSC)  
Major Course***

Name of the Course	Fundamentals of Programming Paradigm
Course Code	USCS102
Class	FYBSC
Semester	I
No of Credits	2
Nature	Theory
Type	Major
Employability/ entrepreneurship/ skill development	This course is new and concentrates on various programming concepts. General overview of programming concepts is introduced in this course. Also the course works on logic building of learners. Main thought behind this course is that 'any learner will get structure of various types/ formats of languages.' This will help learners to learn any language in future.

***Fundamentals of Programming Paradigm  
Modules at a Glance***

Sr. No.	Modules	No. of Lectures
1	Functional Programming, Logical Programming	10
2	Object Oriented Programming	10
3	Scripting Language	10
<b>Total</b>		<b>30</b>

***Course Outcomes***

**Course Outcomes:**

1. To understand basic programming structure.
2. To be able to implement programming structure in various formats.
3. To understand the basic building blocks of programming Languages.

Sr. No.	Modules / Units
1	<b>Fundamental of Programming (10 Lectures)</b>
	Logic Development - Overview of Computers and Logic, Introduction to logic building, Algorithm development, Understanding Program Structure and Design. General Terminology - literals , variables, scope of variable, operators, Special Symbols and its use, Wildcards and its use, Constants variables, static variables, Interface, User Interface, Data, Data Manipulation-Add, Delete, View, Update. Introduction to Control Statement- Various control statement, Loop, Breaking of Loop, Interface, User Interface Types of Language and language hierarchy
2	<b>Functional Programming and Logical Programming (10 Lectures)</b>
	Functional Programming: Language design, why to study programming language, compilation and interpretation, programming environments. Definition of a function: domain and range, total and partial functions, strict functions. Recursion, Referential transparency, Side effects of functions Logical Programming: Basic constructs, Facts: queries, existential queries, conjunctive queries and rules. Definition and semantics of a logic program, Recursive programming: Computational model of logic programming, Goal reduction, Negation in logic programming
3	<b>Object Oriented Programming and Scripting Language (10 Lectures)</b>
	Object Oriented Programming: Basic concepts: objects, classes, methods, overloading methods, messages inheritance: overriding methods, single inheritance, multiple inheritance Interfaces, encapsulation, polymorphism. Scripting Language: What is scripting language, Problem domain(Shell languages, Text processing and report generation, Mathematics and statistics, General purpose scripting, Extension languages), Scripting the world wide web(CGI scripts, Embedded server side script, client side script, Java Applets, XSLT,Python)

### *Learning Resources recommended*

#### **Textbook(s):**

- Programming Language Pragmatics 4<sup>th</sup> edition, Michael Scott, Morgan Kaufmann

#### **Additional Reference(s):**

- “Foundations of Programming Languages Design & Implementation 3<sup>rd</sup> Edition . Roosta Seyed Cenage Learning

***Syllabus of Courses of B.Sc. Computer Science  
Programme at Semester I  
with Effect from the Academic Year 2023-2024  
Department Specific Courses (DSC)  
Major Course***

<b>Name of the Course</b>	<b>Computer Science Practical 1</b>
Course Code	USCS103
Class	FYBSC
Semester	I
No of Credits	2
Nature	Major- Practical
Type	Major-Mandatory
Employability/ entrepreneurship/ skill development	Practical approach is given to understand circuit design and basic programming concepts. For circuit design any simulator can be used. This course also introduces algorithmic development of various problems which will get constructed using concepts taught in theory. previously no internal marking is defined for practical courses. This course will take a 60: 40 evaluation pattern where 60 marks for practical examination at the end of semester and 40 marks will be used for continuous internal evaluation form.
<b><i>Course Outcomes</i></b>	
<b>Course Outcomes:</b>	
<ul style="list-style-type: none"> <li>● To understand basic programming structure.</li> <li>● To be able to implement programming structures in various formats.</li> <li>● To understand the basic building blocks of programming Languages.</li> </ul>	

Course Code	Course Title	Credits
USCS103	Computer Science Practical 1	02
<p><b>Note: The following practical should be implemented with logisim:</b>  <b>Link : logisim : <a href="https://sourceforge.net/projects/circuit/">https://sourceforge.net/projects/circuit/</a></b>  <b>Minimum 20 practicals should be submitted as Journal work.</b></p>		
Sr. No.	Practical Title	
1	Write pseudo code to detect whether a number is even or odd.	
2	Write pseudo code for calculating whether no is prime or not.	
3	Write a pseudocode for calculating the sum of 10 numbers.	
4	Write a pseudo code for calculating Fibonacci series.	
5	Demonstrate and Implement Recursive function for calculating square of a number	
6	Demonstrate and Implement Recursive function for calculating factorial of a number	
7	Write a JavaScript for basic mathematical functions (add, subtract, multiply and division)	
8	Write a JavaScript to compare two numbers.	
9	Write a JavaScript to print the factorial of a number.	
10	Write a JavaScript to change background colour property.	
11	Study and verify the truth table of various logic gates (NOT, AND, OR, NAND, NOR, EX-OR, and EX-NOR).	
12	Simplify given Boolean expression and realize it.	
13	Design and verify a half/full adder	
14	Design and verify half/full subtractor	
15	Design a 4 bit magnitude comparator using combinational circuits.	
16	Design and verify the operation of flip-flops using logic gates.	
17	Verify the operation of a counter.	
18	Verify the operation of a 4-bit shift register.	
19	Design and implement expression using multiplexers / demultiplexers.	
20	Design and implement 3-bit binary ripple counter using JK flip flops.	
21	Simple microprocessor programs for data transfer operations	
22	Simple microprocessor programs for arithmetic & logical transfer operations	

***Syllabus of Courses of B.Sc. Computer Science  
Programme at Semester I  
with Effect from the Academic Year 2023-2024  
Department Specific Courses (DSC)  
Minor Course***

<b>Name of the Course</b>	<b>Applied Mathematics I</b>
Course Code	USCS104
Class	FYBSC
Semester	I
No of Credits	2
Nature	Theory
Type	Minor
Employability/ entrepreneurship/ skill development	This theoretical course will be more calculative and interesting for students. This course emphasizes on basic mathematics concepts which are required for understanding concepts of computer science. Many concepts are required and due course of time it is impossible to cover all concepts. Hence mathematical concepts are divided into three parts which are completed in a cascading semester.

***Applied Mathematics I  
Modules at a Glance***

<b>Sr. No.</b>	<b>Modules</b>	<b>No. of Lectures</b>
1	Set Theory, Functions	10
2	Relations, Recurrence Relations	10
3	Permutations and Combinations, Counting Principles	10
<b>Total</b>		<b>30</b>

***Course Outcomes***

**Course Outcomes:**

- The purpose of the course is to familiarize the prospective learners with mathematical structures that are fundamentally discrete.
- This course will enhance prospective learners' reason and ability to articulate mathematical problems.
- This course will introduce functions, forming and solving recurrence relations and different counting principles. These concepts will be useful to study or describe objects or problems in computer algorithms and programming languages and these concepts can be used effectively in other courses.

Sr. No.	Modules / Units
1	<b>Set Theory, Functions (10 Lectures)</b>
	Language of sets, Language of relation and functions, Definitions Properties of Sets, Algebraic & Boolean Definitions. Definition of function; Domain, co-domain, range of a function; Examples of standard functions such as identity and constant functions, absolute value function, logarithmic and exponential functions, flooring and ceiling functions; Injective, surjective and bijective functions; Composite and inverse functions.
2	<b>Relations, Recurrence Relations (10 Lectures)</b>
	Definition and examples of relation; Properties of relations, Representation of relations using digraphs and matrices; Equivalence relation; Partial Order relation, Hasse Diagrams, maximal, minimal, greatest, least element, Lattices. Definition and Formulation of recurrence relations; Solution of a recurrence relation; Solving recurrence relations- Backtracking method, Linear homogeneous recurrence relations with constant coefficients; Homogeneous solution of linear homogeneous recurrence relation with constant coefficients; Applications- Formulate and solve recurrence relation for Fibonacci numbers, Tower of Hanoi, Intersection of lines in a plane, Sorting Algorithms.
3	<b>Permutations and Combinations, Counting Principles (10 Lectures)</b>
	Permutation without and with repetition; Combination without and with repetition; Binomial numbers and identities: Pascal Identity, Vandermonde's Identity, Pascal triangle, Binomial theorem (without proof) and applications; Multinomial numbers, Multinomial theorem (without proof) and applications Basic Counting Principles (Sum and Product Rule); Pigeonhole Principle (without proof) - Simple examples; Inclusion Exclusion Principle (Sieve formula) (without proof); Counting using Tree diagrams.

### ***Learning Resources recommended***

1. Discrete Mathematics and Its Applications, Seventh Edition by Kenneth H. Rosen, McGraw Hill Education (India) Private Limited. (2011)
2. Discrete Mathematics: SemyourLipschutz, Marc Lipson, Schaum's out lines, McGraw-Hill Inc, 3<sup>rd</sup> edition

### **Additional References:**

1. Elements of Discrete Mathematics: C.L. Liu, Tata McGraw- Hill Edition.
2. Concrete Mathematics (Foundation for Computer Science): Graham, Knuth, Patashnik Second Edition, Pearson Education.
3. Discrete Mathematics: SemyourLipschutz, Marc Lipson, Schaum's out lines, McGraw-Hill Inc.
4. Foundations in Discrete Mathematics: K.D. Joshi, New Age Publication, New Delhi.

Syllabus for F.Y.B.Sc. Computer Science : Implementation Year 2023-24  
**Syllabus of Courses of B.Sc. Computer Science**  
**Programme at Semester I**  
*with Effect from the Academic Year 2023-2024*  
**Department Specific Courses (DSC)**  
**Minor Course Practical**

Name of the Course	Statistics using R Practical
Course Code	USCS105
Class	FYBSC
Semester	I
No of Credits	2
Nature	Practical
Type	Minor
Employability/ entrepreneurship/ skill development	<p>R is a programming language that is becoming very popular in the data analytics and data science field. It provides the foundation to the students on elementary topics of Statistics and prepares them to describe the given data.</p> <p>The students try to know and measure the chance of different events happening and their occurrence numerically.</p> <p>Students understand how probability has been distributed to the different events and standard notions of probability distributions. Students will be able to understand statistical concepts through the implementation in the programming language.</p>

**Statistics using R Practical**  
**Modules at a Glance**

Course Outcomes
<p><b>Course Outcomes:</b></p> <ul style="list-style-type: none"> <li>● Understand how to describe the data with available measures</li> <li>● Learn how to implement statistics concept using R language</li> <li>● Apply probability in real time situations and identify randomness in experiments</li> <li>● Differentiate between types of random variables and its distributions</li> <li>● Study the standard distributions and its properties</li> </ul>

Course Code	Course Title	Credits
USCS105	Statistics using R Practical	02
<b>Note: The following practical should be implemented in R studio</b> <b>Link: R studio: <a href="https://posit.co/download/rstudio-desktop/">https://posit.co/download/rstudio-desktop/</a></b> <b>Minimum 20 practicals should be submitted as Journal work.</b>		
Sr. No.	Practical Title	
1	Frequency distribution and data presentation using R Programming	
2	Create a Measures of central tendency using R Programming	
3	Data entry using, functions, c(), scan (), Creating vectors, Mathematical Operations: ** +/-/*// ^ , exp, log, log10, etc, matrix operations, seq(), split()	
4	Creating vector of text type, useful functions: data, frame R Programming	
5	Implement Frequency distribution using cut(), table() and Data presentation R program.	
6	Understanding Arithmetic mean, Median, mode: grouping and ungrouping data, effect of shift of origin.	
7	Using R can read and write into various file formats like csv, excel, xml etc.	
8	Create a grouped bar chart using R programming language.	
9	Perform Skewness and Kurtosis in R Programming	
10	Create histogram in R programming language.	
11	Create Boxplots in R Programming Language.	
12	Implement various functions to generate binomial distribution.	
13	Implement Kruskal-Wallis test in R programming.	
14	Implement simple linear regression in R programming.	
15	Implement multiple linear regression in R programming	
16	Calculate Sampling Distributions in R programming.	
17	Perform one way ANOVA test in r programming.	
18	Perform Exception Error handling in R programming.	
19	Perform Exception Condition handling in R programming.	
20	Represent data using frequency distribution, Histogram, Ogive curve.	
21	Implementation of the concept of measures of central tendency.	
22	Recognizing Partition values such as Quartiles, Deciles and Percentiles.	
23	Importing/Reading Files in R, Exporting/Writing Files in R.	



***Learning Resources recommended***

**Textbooks:**

1. R Programming : Statistical Analysis with R For Dummies Paperback – 16 May 2017
2. Trivedi, K.S.(2001) : Probability, Statistics, Design of Experiments and Queuing theory, with applications of Computer Science, Prentice Hall of India, New Delhi
3. The Book of R a First Course in Programming and Statistics by Tilman M. Davies.

**Additional References:**

1. Kulkarni, M.B., Ghatpande, S.B. and Gore, S.D. (1999): common statistical tests. Satyajeeet Prakashan, Pune
2. Gupta, S.C. and Kapoor, V.K. (1987): Fundamentals of Mathematical Statistics, S. Chand and Sons, New Delhi
3. Gupta, S.C. and Kapoor, V.K. (1999): Applied Statistics, S. Chand and Son"s, New Delhi

***Syllabus of Courses of B.Sc. Computer Science  
Programme at Semester I  
with Effect from the Academic Year 2023-2024  
Department Specific Courses (DSC)  
Generic / Open Elective (OE) Course***

<b>Name of the Course</b>	<b>Social Media Marketing</b>
Course Code	USOE106
Class	FYBSC
Semester	I
No of Credits	2
Nature	Theory
Type	OE
Employability/ entrepreneurship/ skill development	<p>Enhance Your Employability and Entrepreneurial Skills!</p> <ol style="list-style-type: none"> <li>1. Unlock your potential with our comprehensive social media marketing program!</li> <li>2. Boost your employability: Gain in-demand skills that employers crave in today's digital world.</li> <li>3. Unleash your entrepreneurial spirit: Learn how to leverage social media platforms to create and grow your own successful business.</li> <li>4. Master the art of engagement: Discover effective strategies to captivate your audience, increase brand visibility, and drive conversions.</li> <li>5. Stay ahead of the competition: Stay up-to-date with the latest trends and best practices in social media marketing.</li> </ol>

***Introduction to Social Media  
Modules at a Glance***

<b>Sr. No.</b>	<b>Modules</b>	<b>No. of Lectures</b>
1	Introduction to Social Media	10
2	Understanding Social Media and tools	10
3	Introduction to Social Media Marketing	10
<b>Total</b>		<b>30</b>

<b>Course Outcomes</b>	
1.	To know the importance of Social media Platforms and importance of Social media in Digital Marketing.
2.	Demonstrate an understanding of social media, the various channels through which it operates, and its role in marketing strategy.
3.	Identify globally acceptable best practices for digital and social media marketing.

<b>Sr. No.</b>	<b>Modules / Units</b>
<b>1</b>	<b>Introduction to Social Media (10 Lectures)</b>
	What is Social Media & its significance? , Necessity of Social media, The changing face of social media, Social Media Past and Present, Who owns the social Media, Classification of Social Media, Identification of social media, Profile Creation, expanding the network, Engagement.
<b>2</b>	<b>Understanding Social Media and tools (10 Lectures)</b>
	Monitoring and Analysis, Needs of Social Media in business, Benefits of social media for individuals, Benefits of social media for Business, Social Networking, Photo and Video Sharing, Blogs, Micro Blog, Social Curation, Reviews and Ratings, Location, Business Networking, Social Gaming.
<b>3</b>	<b>Introduction to Social Media Marketing (10 Lectures)</b>
	History of Social Media Marketing, Importance of Social Media, Facebook Marketing, LinkedIn Marketing, Pinterest Marketing, Video Marketing, Social Bookmarking, Image Optimization.

<b>Learning Resources recommended</b>
<p><b>Textbook(s):</b></p> <ol style="list-style-type: none"> <li>1. Understanding Social Media by Varinder Taprial, Priya Kanwar</li> </ol> <p><b>Additional Reference(s):</b></p> <ol style="list-style-type: none"> <li>2. Social Media Marketing by tutorialspoint.com</li> </ol>

***Syllabus of Courses of B.Sc. Computer Science  
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with Effect from the Academic Year 2023-2024  
Department Specific Courses (DSC)***

***Indian Knowledge System (IKS) Course***

Name of the Course	Evolution of Computing in India
Course Code	USCS106
Class	FYBSC
Semester	I
No of Credits	02
Nature	Theory
Type	IKS
Employability/ entrepreneurship/ skill development	<p>The early stages of India's computer industry required a combination of technical expertise, visionary leadership, strategic planning, collaboration, innovation, and resource management. These skills collectively laid the foundation for the growth and development of the computer industry in the country.</p> <p>The individuals and leaders involved in the early efforts to establish the computer industry in India exhibited visionary thinking and strategic planning. Advocating the importance of computers and their potential impact on various sectors of society was a critical skill in garnering support and resources. Efficiently managing resources, both financial and technological, to acquire and set up the first computer was essential.</p> <p>Developing comprehensive plans and strategies to promote the growth of the computer industry as a driver of economic and technological development. Policies that emphasized education and training in computer-related fields contributed to a skilled workforce in technology. Skills in policy formulation, strategic planning, stakeholder engagement, and economic analysis were pivotal in achieving the desired outcomes and fostering sustainable growth in the technology sector.</p> <p>Anticipating future technological trends and innovating to stay relevant in a rapidly evolving industry. Adapting to varying international regulations and compliance standards while conducting business abroad. Contributing to a dynamic innovation ecosystem through research, development, and technology-driven solutions.</p>

***Evolution of Computing in India  
Modules at a Glance***

Sr. No.	Modules	No. of Lectures
1	Computing Science in Ancient India	10
2	Contribution in Computing in 19 <sup>th</sup> Century	10
3	Government Policies and Status of IT industry	10
<b>Total</b>		<b>30</b>

***Course Outcomes***

1. To understand the history of Computer system in India.
2. To understand government policies for inculcating the IT industry in India.
3. To understand structure of IT industry
4. To understand the struggle of India for creating the country as an IT hub.
5. To understand the Future of IT industry in India

Sr. No.	Modules / Units
<b>1</b>	<b>Computing Science in Ancient India (10 Lectures)</b>
	An overview of Ancient Indian Science - Vedic Cognitive science, mathematical and physical science, Scientist of ancient India, Binary numbers in Indian Antiquity -Pingala's classification of Meters, Encode decode system in Ancient India- Katayapadi Scheme, Panini's contribution in computing -The Panini-Backus Form, Fowlers' automaton .
<b>2</b>	<b>Contribution in Computing in 19<sup>th</sup> Century (10 Lectures)</b>
	Laying the foundation, First computer in India, TIFRAC, Self-reliant growth of computer industry, ECIL's computer division, PARAM super computer, NASSCOM, Contribution of CDAC, Development of multilingual software. Indian computer scientist, Indian IT industrialist.
<b>3</b>	<b>Government Policies and Status of IT industry (10 Lectures)</b>
	Economy of India, Government initiative, Role of government institution & Ministry of Information Technology, Government Policies at early stage and revised policies, Consequences of Government policies., Entry of private sector in computer industry, Liberalization of economy and software expert growth, The period of rapid growth of IT industry, Indian IT industry in global perspective, Indian ICT industry in global perspective, Future of IT industry

***Learning Resources recommended***

**Book(s):**

**Learning Resources Recommended:**

1. “Computing science in Ancient India”, T.R.N. Rao / Subhash Kak
2. “History of Computing in India 1955-2010”, V. Rajaraman, IEEE Computer Society
3. “Homi Bhabha and the Computer Revolution”, R.K. Shyamsunder and M. A. Pai, Oxford University, 2011

**Additional references:**

1. <https://www.scribd.com/document/57187049/History-of-Computer-Technology-in-India#>
2. <https://en.m.wikipedia.org/wiki/TCIFRAC>
3. [https://en.m.wikipedia.org/wiki/Information\\_technology\\_in\\_India](https://en.m.wikipedia.org/wiki/Information_technology_in_India)

**Syllabus of Courses of B.Sc. Computer Science**  
**Programme at Semester I**  
**with Effect from the Academic Year 2023-2024**  
**Department Specific Courses (DSC)**  
**Vocational Skill Course (VSC)**

<b>Name of the Course</b>	<b>Programming with Python Practical</b>
Course Code	USCS107
Class	FYBSC
Semester	I
No of Credits	2
Nature	Practical
Type	VSC
Employability/ entrepreneurship/ skill development	In past curriculum, Programming with Python was a course based on theory and practical approach. Python is a language which will get learned with hands-on training. Hence to develop practical approach the more trace is given on practical in this course. This will help learners to become more practically sound in programming language.

**Course Outcomes**

1. To learn how to design and program Python applications.
2. To explore the innards of Python Programming and understand components of Python Program To define the structure and components of a Python program.
3. To learn how to write loops and decision statements in Python
4. To learn about inbuilt input/output operations and compound data types in Python

Course Code	Course Title	Credits
USCS107	Programming with Python Practical	02
<p><b>Note: The following practical should be implemented in Python IDLE</b>  <b>Link: Python IDLE : <a href="https://www.python.org/downloads/">https://www.python.org/downloads/</a></b>  <b>Minimum 20 practical's should be submitted as Journal work.</b></p>		
Sr. No.	Aim of the Practical	Literature
1	Introduction to Python IDLE, Python Shell	Information about IDLE, Diagram of IDLE, Menus and three commands delivering information about python
2	Understanding of Literal and variables	Information about literal (integer, float, character, string, etc...) and variable
3	Illustration of I/O functions such as print(), int(), float() functions	Syntax and examples of all functions
4	Use of Operators in Python	Information about all Operators
5	Implementation of simple programs	All the programs with statements containing basic I/O functions, operators, etc..

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6	Understanding if statement	Syntax of if statement, if else statement, elif ladder, programs examining all types of if statement
7	Understanding while statement	Syntax of while statement, while else statement, break statement, continue statement , programs examining all types of while statement
8	Understanding for statement	Syntax of for statement, for else statement, range() function, programs examining all types of for statement
9	Understanding modules in python	Concept of modules, examining various modules such as math module, random module, time module
10	Implementation of List data structure in python	Information of list and all operations performed on list, programs on list and list operation
11	Implementation of Dictionary data structure in python	Information of dictionary and all operations performed on dictionary, programs on dictionary and dictionary operation
12	Implementation of Tuple data structure in python	Information about tuple and demonstrative program on Tuple
13	Implementation of Functions	Syntax of function definition, function call, concept of local and global parameters and programs on functions
14	Illustration of Exception handling	Demonstration of programs on exception handling
15	File handling	File handling concepts and programs to examine file handling concepts
16	Database handling	Database concepts, CRUD operations Write a Python Program to work with databases in Python to perform operations such as a. Connecting to database b. Creating and dropping tables c. Inserting and updating into tables.
17	Database handling	Concept of Transaction handling, Join operation, Python Programs to perform transactions.
18	GUI programming	GUI concepts with widgets and layout manager, GUI Programs in Python to design application that implements a. Different Widgets b. Different Layout Managers
19	GUI programming	Illustration of concept of event driven programming, demonstrative GUI programs in python to design application that demonstrates Different Fonts and Colors Event Handling
20	Networking	Concept of networking, connection-oriented server client communication, a Python program to create server-client and exchange basic information.
21	Networking	Connection less server client communication and its implementation
22	OOP concept	Concepts of OOP, Python programs to implement



		<p>concepts of OOP such as</p> <ol style="list-style-type: none"> <li>a. Types of Methods</li> <li>b. Inheritance</li> <li>c. Polymorphism</li> </ol>
23	OOP Concept	<p>Python programs to implement concepts of OOP such as</p> <ol style="list-style-type: none"> <li>a. Abstract methods and classes</li> <li>b. Interfaces</li> </ol>

### ***Learning Resources recommended***

#### **Textbooks:**

1. Practical Programming: An Introduction to Computer Science Using Python 3, Paul Gries , Jennifer Campbell, Jason Montojo, Pragmatic Bookshelf, 2nd Edition, 2014
2. Programming through Python, M. T Savaliya, R. K. Maurya& G M Magar, Sybgen Learning India, 2020

#### **Additional References:**

1. Python: The Complete Reference, Martin C. Brown, McGraw Hill, 2018
2. Beginning Python: From Novice to Professional, Magnus Lie Hetland, Apress, 2017
3. Programming in Python 3, Mark Summerfield, Pearson Education, 2nd Ed, 2018
4. Python Programming: Using Problem Solving Approach, ReemaThareja, Oxford Univeristy Press, 2017
5. Let Us Python, Yashwant. B. Kanetkar, BPB Publication, 2019

***Syllabus of Courses of B.Sc. Computer Science  
Programme at Semester I  
with Effect from the Academic Year 2023-2024  
Department Specific Courses (DSC)  
Ability Enhancement Course (AEC)***

Name of the Course	Soft Skill Development - I
Course Code	USCS108
Class	FYBSC
Semester	I
No of Credits	2
Nature	Theory
Type	AEC I
Employability/ entrepreneurship/ skill development	The main aim of the paper is to learn basic communication skills required in the IT industry. To help learners develop their soft skills and develop their personality along with technical skills. Focus on various communication enhancement along with academic and professional ethics.

***Soft Skill Development - I  
Modules at a Glance***

Sr. No.	Mod ules	No. of Lectures
1	Soft Skills: An Introduction, Personality Development, Communication Skills, Etiquettes and Mannerism	10
2	Employment Communication, Job Interviews, Group Discussion	10
3	Professional Presentation, Leadership and Team Building, Stress and Time Management	10
<b>Total</b>		<b>30</b>

***Course Outcomes***

1. Understand the significance and essence of a wide range of soft skills.
2. Learn how to apply soft skills in a wide range of routine social and professional settings
3. Learn how to employ soft skills to improve interpersonal relationships
4. Learn how to employ soft skills to enhance employability and ensure workplace and career success

Sr. No.	Modules / Units
1	<b>Soft Skills: An Introduction, Personality Development, Communication Skills, Etiquettes and Mannerism (10 Lectures)</b>
	Definition and Significance of Soft Skills; Process, Importance and Measurement of Soft Skill Development, Identifying your soft skills, SWOT analysis Knowing Yourself, Positive Thinking, Johari's Window, Effective communication Spoken English, Phonetics, Accent, Intonation Introduction, Professional Etiquette, Technology Etiquette.
2	<b>Employment Communication, Job Interviews, Group Discussion (10 Lectures)</b>
	Introduction, Resume, Curriculum Vitae, Scannable Resume, Developing an Impressive Resume, Formats of Resume, Job Application or Cover Letter Introduction, Importance of Resume, Definition of Interview, Background Information, Types of Interviews, Preparatory Steps for Job Interviews, Interview Skill Tips, Introduction, Ambience/Seating Arrangement for Group Discussion, Importance of Group Discussions, Types of Group Discussions
3	<b>Professional Presentation, Leadership and Team Building, Stress and Time Management (10 Lectures)</b>
	Nature of Oral Presentation, planning a Presentation, Preparing the Presentation, Delivering the Presentation Leader and Leadership, Leadership Traits, Culture and Leadership, Leadership Styles and Trends, Team Building, Types of Teams. Stress, Sources of Stress, Ways to Cope with Stress.

### ***Learning Resources recommended***

#### **Textbook(s):**

1. Managing Soft Skills for Personality Development – edited by B.N.Ghosh, McGraw Hill India, 2017.
2. Soft Skills: An Integrated Approach to Maximize Personality, Gajendra S. Chauhan, Sangeeta Sharma, Wiley India

#### **Additional References:**

1. Personality Development and Soft Skills, Barun K. Mitra, Oxford Press
2. Business Communication, ShaliniKalia, Shailja Agrawal, Wiley India
3. Cornerstone: Developing Soft Skills, Sherfield, Pearson India

**Syllabus of Courses of B.Sc. Computer Science  
Programme at Semester I  
with Effect from the Academic Year 2023-2024  
Department Specific Courses (DSC)  
Value Education Course (VEC)**

<b>Name of the Course</b>	<b>Green Computing I</b>
Course Code	USCS109
Class	FYBSC
Semester	I
No of Credits	2
Nature	Theory
Type	VEC
Employability/ entrepreneurship/ skill development	Being a green in the IT field is a need in today's era. Harmful components present in the system may cause damage to the environment if not properly disposed of. Hence to give a more concentration on this concern, syllabus tried to cover all issues related with green technology. This vast topic is covered in two parts. Second semester will be a continuation of the first semester.

**Green Computing I  
Modules at a Glance**

<b>Sr. No.</b>	<b>Modules</b>	<b>No. of Lectures</b>
1	Green IT Overview, Green Devices and Hardware	10
2	Green Software, Sustainable Software Development	10
3	Green Data Centers, Green Data Storage	10
<b>Total</b>		<b>30</b>

**Course Outcomes**

1. Learn about green IT can be achieved in and by hardware, software, network communication and data center operations.
2. Understand the strategies, frameworks, processes and management of green IT
3. Understand energy resource management

Sr. No.	Modules / Units
1	<b>Green IT Overview, Green Devices and Hardware (10 Lectures)</b>
	Introduction, Environmental Concerns and Sustainable Development, Environmental Impacts of IT, Green I , Holistic Approach to Greening IT, Greening IT, Applying IT for Enhancing Environmental Sustainability, Green IT Standards and Eco-Labeling of IT , Enterprise Green IT Strategy, Green Washing, Green IT: Burden or Opportunity? Introduction , Life Cycle of a Device or Hardware, Reuse, Recycle and Dispose
2	<b>Green Software, Sustainable Software Development (10 Lectures)</b>
	Introduction, Processor Power States , Energy-Saving Software Techniques, Evaluating and Measuring Software Impact to Platform Power Introduction, Current Practices, Sustainable Software, Software Sustainability Attributes, Software Sustainability Metrics, Sustainable Software Methodology, Defining Actions
3	<b>Green Data Centers, Green Data Storage (10 Lectures)</b>
	Data Centers and Associated Energy Challenges, Data Centre IT Infrastructure, Data Centre Facility Infrastructure: Implications for Energy Efficiency, IT Infrastructure Management, Green Data Centre Metrics Introduction , Storage Media Power Characteristics, Energy Management Techniques for Hard Disks, System-Level Energy Management

### ***Learning Resources recommended***

#### **Book(s):**

1. Harnessing Green IT: Principles and Practices, San Murugesan, G. R. Ganadharan, Wiley & IEEE.

#### **Additional References:**

1. Green IT, Deepak Shikarpur, Vishwkarma Publications, 2014
2. Green Communications: Principles, Concepts and Practice- Samdanis et al, J. Wiley
3. Green IT for Sustainable Business Practice: An ISEB Foundation Guide, Mark G. O'Neill, The Chartered Institute for IT, 2010

**Semester II**  
**Syllabus of Courses of B.Sc. Computer Science**  
**Programme at Semester II**  
**with Effect from the Academic Year 2023-2024**  
**Department Specific Courses (DSC)**  
**Major Course**

Name of the Course	Database system
Course Code	USCS201
Class	FYBSC
Semester	II
No of Credits	2
Nature	Theory
Type	Major
Employability/ entrepreneurship/ skill development	Database is a core concept that every IT professional needs to know. All the basic concepts of database are included in this course. This course will make learners aware about the database concepts and they can learn advanced concepts. Due to the course schedule only necessary concepts are mentioned in this course.  Indexes and views are taken as a part of theory. Data models which are included in previous course are omitted as per time constraints. Concepts which are used frequently and need more attention are included in course.

**Database system**  
**Modules at a Glance**

Sr. No.	Modules	No. of Lectures
1	Introduction to DBMS, Entity Relationship Model, DDL Statements DML Statements	10
2	Relational data model, Relational Algebra, Functions, Joining Tables, Sub-queries	10
3	Schema refinement and Normal forms, Database Protection, Transaction control commands	10
<b>Total</b>		<b>30</b>

**Course Outcomes**

The learner will be able to

1. To make students aware fundamentals of database system.
2. To give idea how ERD components helpful in database design and implementation.
3. To experience the students working with database using MySQL.
4. To familiarize the student with normalization, database protection and different DCL Statements.
5. To make students aware about importance of protecting data from unauthorized users.

Sr. No.	Modules / Units
1	<p><b>Introduction to DBMS,Entity Relationship Model,DDL Statements</b></p> <p><b>DML Statements (10 Lectures)</b></p>
	<p>Introduction to DBMS            Database, DBMS – Definition, Overview of DBMS, Advantages of DBMS, Levels of abstraction, Data independence, DBMS Architecture            Entity Relationship Model            Entities, attributes, entity sets, relations, relationship sets, Additional constraints (key constraints, participation constraints, weak entities, aggregation / generalization, Conceptual Design using ER (entities VS attributes, Entity Vs relationship, binary Vs ternary, constraints beyond ER)            DDL Statements            - Creating Databases, Using Databases, datatypes, Creating Tables (with integrity constraints – primary key, default, check, not null), Altering Tables, Renaming Tables, Dropping Tables, Truncating Tables            DML Statements            Viewing the structure of a table insert, update, delete, Select all columns, specific columns, unique records, conditional select, in clause, between clause, limit, aggregate functions (count, min, max, avg, sum), group by clause, having clause</p>
2	<p><b>Relational data model, Relational Algebra, Functions ,Joining Tables, Sub-queries (10 Lectures)</b></p>
	<p>Relational data model : Domains, attributes, Tuples and Relations, Relational Model Notation, Characteristics of Relations, Relational Constraints - primary key, referential integrity, unique constraint, Null constraint, Check constraint            Relational Algebra : Operations (selection, projection, set operations union, intersection, difference, cross product, Joins –conditional, equi join and natural joins, division)            Functions : String Functions (concat, instr, left, right, mid, length, lcase/lower, ucase/upper, replace, strcmp, trim, ltrim, rtrim), Math Functions (abs, ceil, floor, mod, pow, sqrt, round, truncate) Date Functions (adddate, datediff, day, month, year, hour, min, sec, now, reverse)            Joining Tables. Inner join, outer join (left outer, right outer, full outer)            Subqueries : Subqueries with IN, EXISTS, subqueries restrictions, Nested subqueries, ANY/ALL clause, correlated subqueries.</p>
3	<p><b>Schema refinement and Normal forms, Database Protection , Transaction control commands Architecture (10 Lectures)</b></p>
	<p>Schema refinement and Normal forms : Functional dependencies, first, second, third, and BCNF normal forms based on primary keys, lossless join decomposition.</p> <p>Database Protection: Security Issues, Threats to Databases, Security Mechanisms, Role of DBA, Discretionary Access Control, Backing Up and Restoring databases            Transaction control commands: Commit, Rollback</p>

***Learning Resources recommended***

**Textbooks:**

1. “Fundamentals of Database System”, ElmasriRamez, NavatheShamkant, Pearson Education, Seventh edition, 2017
2. “Database Management Systems”, Raghu Ramakrishnan and Johannes Gehrke, 3rd Edition, 2014
3. “Murach's MySQL”, Joel Murach, 3rd Edition, 3rd Edition, 2019

**Additional References:**

1. “Database System Concepts”, Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw Hill, 2017
2. “MySQL: The Complete Reference”, Vikram Vaswani, McGraw Hill,



**Syllabus of Courses of B.Sc. Computer Science  
Programme at Semester II  
with Effect from the Academic Year 2023-2024  
Department Specific Courses (DSC)  
Major Course**

<b>Name of the Course</b>	<b>Programming with C++</b>
Course Code	USCS202
Class	FYBSC
Semester	II
No of Credits	2
Nature	Theory
Type	Major
Employability/ entrepreneurship/ skill development	As being a new structure and object oriented language; course delivers constructs of C++. Introduction of UML and concepts of UML such as class diagram will get included in software engineering which will get introduced in the upcoming year. This course illustrates implementation of object oriented programming through C++. The highly configured objects are formed by taking the help of the C++. Hence the course 'Programming with C++' is included in the program.

**Programming with C++  
Modules at a Glance**

<b>Sr. No.</b>	<b>Modules</b>	<b>No. of Lectures</b>
1	Introduction to C++, Data Types, Data Input Output and Operators, Decision Making, Loops, Arrays and Strings, Classes, Abstraction & Encapsulation	10
2	Constructors and Destructors, Working with objects, Polymorphism	10
3	Inheritance, Pointers, File Handling	10
<b>Total</b>		<b>30</b>

**Course Outcomes**

The learner will be able to

1. After successful completion of this course, students would be able to Work with numeric, character and textual data and arrays.
2. Understand the importance of OOP approach over procedural language.
3. Apply the concepts of OOPS like encapsulation, inheritance and polymorphism. Handle basic file operations.

Sr. No.	Modules / Units
1	<b>Introduction to C++,Data Types, Data Input Output and Operators, Decision Making, Loops, Arrays and Strings, Classes, Abstraction &amp; Encapsulation (10 Lectures)</b>
	<p>Introduction to C++: Features of C++ and its basic structure, simple C++ program without class, compiling and running C++ program.</p> <p>Data Types, Data Input Output and Operators :Basic data types, variables, rules for naming variables, programming constants, the type cast operator, implicit and explicit type casting, cout and cin statements, operators, precedence of operators.</p> <p>Decision Making, Loops, Arrays and Strings: Conditional statements-if, if...else, switch loops- while, do...while, for, types of arrays and strings</p> <p>Classes, Abstraction &amp; Encapsulation: Classes and objects, Dot Operator, data members, member functions, passing data to functions, scope and visibility of variables in function.</p>
2	<b>Constructors and Destructors,Working with objects, Polymorphism (10 Lectures)</b>
	<p>Constructors and Destructors: Default constructor, parameterized constructor, copy constructor, private constructor, destructors.</p> <p>Working with objects Accessor - mutator methods, static data and static function, access specifiers, array of objects.</p> <p>Polymorphism: Binding-static binding &amp; overloading, constructor overloading function overloading, operator overloading, overloading unary and binary operators.</p> <p>Run time Polymorphism</p>
3	<b>Inheritance, Pointers, File Handling (10 Lectures)</b>
	<p>Inheritance: Defining base class and its derived class, access specifiers, types of inheritance-single, multiple, hierarchical, multilevel, hybrid inheritance, friend function and friend class, constructors in derived classes.</p> <p>Pointers : Introduction to pointers, * and &amp; operators, assigning addresses to pointer variables, accessing values using pointers, pointers to objects &amp; this pointer, pointers to derived classes</p> <p>File Handling: File Stream classes, opening and closing file-file opening modes, text file handling, binary file handling.</p>

**Learning Resources recommended****Textbooks:**

1. Object Oriented Programming with C++, Balagurusamy E., 8th Edition, McGraw Hill Education India.
2. UML & C++: A Practical Guide to Object Oriented Development, Lee/Tepfenhart, Pearson Education, 2<sup>nd</sup> Edition 2015

**Additional References:**

1. Mastering C++ by Venugopal, Publisher: McGraw-Hill Education, 2017
2. Let Us C++ by Kanetkar Yashwant, Publisher: BPB Publications, 2020
3. Object Oriented Analysis and Design by Timothy Budd TMH, 2001

**Syllabus of Courses of B.Sc. Computer Science  
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Department Specific Courses (DSC)  
Major Course**

<b>Name of the Course</b>	<b>Computer Science Practical 2</b>
Course Code	USCS203
Class	FYBSC
Semester	II
No of Credits	2
Nature	Major- Practical
Type	Major-Mandatory
Employability/ entrepreneurship/ skill development	These course focuses on practical implementation of databases and C++. Giving hands on theory topics helps to understand theoretical concepts very easily. Previously no internal marking was defined for practical courses. This course will take a 75: 25 evaluation pattern where 75 marks for practical examination at the end of semester and 25 marks will be used for continuous internal evaluation form.
<b>Course Outcomes</b>	
<p><b>Course Outcomes:</b></p> <ol style="list-style-type: none"> <li>1. To make students aware of the fundamentals of the database system.</li> <li>2. To give an idea how ERD components are helpful in database design and implementation.</li> <li>3. To experience the students working with databases using MySQL.</li> <li>4. To familiarize the student with normalization.</li> <li>5. To be able to implement programming structures in various formats.</li> <li>6. To understand the basic building blocks of programming Languages.</li> <li>7. Work with numeric, character and textual data and arrays.</li> <li>8. Apply the concepts of OOPS like encapsulation, inheritance and polymorphism. Handle basic file operations.</li> </ol>	

Course Code	Course Title	Credits
USCS203	Computer Science Practical 2	02
<b>Note: The following practical should be implemented in MySQL and Turbo C</b> <b>Link: MySQL (S/W) <a href="https://www.mysql.com/downloads/">https://www.mysql.com/downloads/</a></b> <b>Minimum 20 practical's should be submitted as Journal work.</b>		
Sr. No.	Practical Title	
1	Conceptual Designing using ER Diagrams (Identifying entities, attributes, keys and relationships between entities, cardinalities, generalization, specialization etc.)	
2	Perform the following: <ul style="list-style-type: none"> <li>Viewing all databases</li> <li>Creating a Database</li> <li>Viewing all Tables in a Database</li> <li>Creating Tables (With and Without Constraints)</li> <li>Inserting/Updating/Deleting Records in a Table</li> </ul>	
3	Perform the following: <ul style="list-style-type: none"> <li>Altering a Table</li> <li>Dropping/Truncating/Renaming Tables</li> <li>Backing up / Restoring a Database</li> </ul>	
4	Perform the following: <ul style="list-style-type: none"> <li>Simple Queries</li> <li>Simple Queries with Aggregate functions</li> </ul>	
5	Queries involving <ul style="list-style-type: none"> <li>Date Functions</li> <li>String Functions</li> <li>Math Functions</li> </ul>	
6	Sub queries <ul style="list-style-type: none"> <li>With IN clause</li> <li>With EXISTS clause</li> </ul>	
7	Converting ER Model to Relational Model and apply Normalization on database. (Represent entities and relationships in Tabular form, Represent attributes as columns, identifying keys and normalization up to 3rd Normal Form).	
8	Views Creating Views (with and without check option) Dropping views Selecting from a view	
9	Program to demonstrate use of data members & member functions.	
10	Programs based on branching and looping statements using classes.	
11	Program to demonstrate one- and two-dimensional arrays using classes	
12	Program to use scope resolution operator. Display the various values of the same variables declared at different scope levels.	
13	Programs to demonstrate various types of constructors and destructors.	
14	Programs to demonstrate use of public, protected & private scope specifiers.	
15	Programs to demonstrate single and multilevel inheritance.	
16	Programs to demonstrate multiple inheritance and hierarchical inheritance.	

17	Programs to demonstrate inheritance and derived class constructors.
18	Programs to demonstrate friend function, inline function, this pointer.
19	Programs to demonstrate function overloading and overriding.
20	Programs to demonstrate use of pointers.
21	Programs to demonstrate text and binary file handling.

### ***Learning Resources recommended***

#### **Textbooks:**

1. "Fundamentals of Database System", ElmasriRamez, NavatheShamkant, Pearson Education, Seventh edition, 2017
2. "Database Management Systems", Raghu Ramakrishnan and Johannes Gehrke, 3rd Edition, 2014
3. "Murach's MySQL", Joel Murach, 3rd Edition, 3rd Edition, 2019
4. Object Oriented Programming with C++, Balagurusamy E., 8th Edition, McGraw Hill Education India.
5. UML & C++: A Practical Guide to Object Oriented Development, Lee/Tepfenhart, Pearson Education, 2<sup>nd</sup> Edition2015.

**Syllabus of Courses of B.Sc. Computer Science**  
**Programme at Semester II**  
**with Effect from the Academic Year 2023-2024**  
**Department Specific Courses (DSC)**  
**Minor Course**

<b>Name of the Course</b>	<b>Applied Mathematics II</b>
Course Code	USCS204
Class	FYBSC
Semester	II
No of Credits	2
Nature	Theory
Type	Minor
Employability/ entrepreneurship/ skill development	This course tries to cover a few more concepts of mathematics which are lagged in semester I due to course schedule. Concentration of this course is on derivatives and integration. These concepts helps learners to understand machine learning, optimization concepts.

**Applied Mathematics II**  
**Modules at a Glance**

Sr. No.	Modules	No. of Lectures
1	Derivative, Partial Derivatives	10
2	Integration, Applications of Integration	10
3	Random Variables, Standard Probability distributions	10
<b>Total</b>		<b>30</b>

**Course Outcomes**

**Course Outcomes:**

- The primary objective of this course is to introduce the basic tools of Calculus which are helpful in understanding their applications to the real world problems.
- It covers topics from as basic as definition of functions to partial derivatives of functions in a gradual and logical way.
- The learner is expected to solve as many examples as possible to a get compete clarity and understanding of the topics covered.
- To make learner aware about basic probability axioms and rules and its application. To understand the concept of conditional probability and Independence of events.
- To make learner familiar with discrete and continuous random variables as well as standard discrete and continuous distributions.

Sr. No.	Modules / Units
1	<b>Derivative, Partial Derivatives (10 Lectures)</b>
	Derivative In Graphing And Applications: Increase, Decrease, Concavity, Relative Extreme; Graphing Polynomials, Rational Functions, Cusps and Vertical Tangents. Absolute Maxima and Minima, Applied Maximum and Minimum Problems, Newton's Method. Partial Derivatives, Differentiability, Differentials, and Local Linearity, Chain Rule, Implicit Differentiation, Directional Derivatives and Gradients
2	<b>Integration, Applications of Integration (10 Lectures)</b>
	An Overview of the Area Problem, Indefinite Integral, Definition of Area as a Limit; Sigma Notation, Definite Integral, Evaluating Definite Integrals by Substitution, Numerical Integration: Simpson's Rule. Area between two curves, Length of a plane curve.
3	<b>Random Variables, Standard Probability distributions (10 Lectures)</b>
	Concept and definition of a discrete random variable and continuous random variable. Probability mass function, Probability density function and cumulative distribution function of discrete and continuous random variable, Properties of cumulative distribution function. Introduction, properties, examples and applications of each of the following distributions: Binomial distribution, Normal distribution, Chi-square distribution, t distribution, F distribution

### ***Learning Resources recommended***

#### **Learning Resources recommended:**

1. Calculus: Early transcendental (10th Edition): Howard Anton, IrlBivens, Stephen Davis, John Wiley & sons, 2012.
2. Gupta, S.C. and Kapoor, V.K. (1987): Fundamentals of Mathematical Statistics, S. Chand and Sons, New Delhi
3. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta

#### **Additional References:**

1. Mood, A. M. and Graybill, F. A. and Boes D.C. (1974). Introduction to the Theory of Statistics, Ed. 3, McGraw Hill Book Company.

***Syllabus of Courses of B.Sc. Computer Science  
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Department Specific Courses (DSC)  
Minor Course***

Name of the Course	Data Structures
Course Code	USCS205
Class	FYBSC
Semester	II
No of Credits	2
Nature	Theory
Type	Minor
Employability/ entrepreneurship/ skill development	The course focuses to give an understanding of different types of data structures that can be used to store data in memory, how to create-manipulate them and to use them in the best possible manner as per the requirements of the application. Understanding the data structures used in computer system will help them how data gets organized in memory. This will help them in the development of their software related to memory management.

***Data Structures  
Modules at a Glance***

Sr. No.	Modules	No. of Lectures
1	Derivative, Partial Derivatives	10
2	Integration, Applications of Integration	10
3	Random Variables, Standard Probability distributions	10
<b>Total</b>		<b>30</b>

***Course Outcomes***

**Course Outcomes:**

- To introduce data abstraction and data representation in memory
- To describe, design and use of elementary data structures such as stack, queue, linked list, tree and graph
- How and why different data structures are used for different types of problems.



Sr. No.	Modules / Units
1	<b>Abstract data Type, Linked Structures, Stacks, Queues (10 Lectures)</b>
	Different Data Types, different types of data structures & their classifications, Introduction to ADT ADT for linked list, Advantages & Disadvantages, Singly Linked List-Traversing, Searching, Prepending and Removing Nodes Stack ADT for Stack, Advantages & Disadvantages, Applications of stack Queue ADT, Advantages & Disadvantages, linked representations. Circular Queue operations, Dequeues
2	<b>Doubly Linked list, Trees, Priority Queues &amp; Heaps (10 Lectures)</b>
	ADT of doubly linked list, Advantages & Disadvantages, Insertion and deletion of nodes at various positions ADT for Tree Structure. Advantages & disadvantages, Binary Tree-Properties, Implementation and Traversals, Binary Search Tree, Balanced BST, Threaded Binary Trees, AVL Trees, Applications of Tree like Huffman Coding Priority Queue, Priority Queue ADT, Advantages and Disadvantages, Applications, Heaps, types of heaps, Heapifying the element
3	<b>Graph, Hashing (10 Lectures)</b>
	Introduction, Graph ADT, Advantages and Disadvantages, Graph Representation using adjacency matrix and adjacency list, Graph operations like insertion and deletion of nodes, Graph Traversals using BFS & DFS, Applications of Graphs like shortest path algorithms, Hash Table ADT, Advantages & Disadvantages, Concept of hashing, hash table, hash functions, collision, collision avoidance techniques, Applications of hashing

### ***Learning Resources recommended***

#### **Textbooks:**

1. Introduction to Algorithm, Thomas H Cormen, PHI
2. Data Structures And Algorithms Made Easy, Narasimha Karumanchi, 2021.

#### **Additional References:**

1. Fundamentals of Computer Algorithms, Sartaj Sahni and Sanguthevar Rajasekaran Ellis Horowitz, Universities Press, 2018
2. Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Wiley, 2016

**Syllabus of Courses of B.Sc. Computer Science  
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Department Specific Courses (DSC)  
Minor Course Practical**

<b>Name of the Course</b>	<b>Minor-Practical</b>
Course Code	USCS206
Class	FYBSC
Semester	II
No of Credits	2
Nature	Practical
Type	Minor
Employability/ entrepreneurship/ skill development	Mathematics serves as a base for Computer Science. This paper helps in logic building and basic computational techniques. Previously no internal marking was defined for practical courses. This course will take a 60: 40 evaluation pattern where 60 marks for practical examination at the end of semester and 40 marks will be used for continuous internal evaluation form.

**Minor-Practical  
Data Structure  
Modules at a Glance**

<b>Course Outcomes</b>
<p><b>Course Outcomes:</b></p> <ul style="list-style-type: none"> <li>● To make students aware of different fundamental data structures.</li> <li>● To describe, design and use of elementary data structures such as stack, queue, linked list, tree and graph</li> <li>● To build strong logic foundation for mathematics</li> <li>● Know basic methods for series generation</li> </ul>

<b>Course Code</b>	<b>Course Title</b>	<b>Credits</b>
USCS203	Minor-Practical	02
<p><b>Note: The following practical should be implemented with Python IDLE and SageMath.</b>  <b>Link: SageMath: <a href="https://www.sagemath.org/download-windows.html">https://www.sagemath.org/download-windows.html</a></b>  <b>Link: Python IDLE: <a href="https://www.python.org/downloads/">https://www.python.org/downloads/</a></b>  <b>Minimum 20 practicals should be submitted as Journal work.</b></p>		
Sr. No.	Practical Title	
1	Implement Continuity of functions and Derivative of functions with suitable example.	
2	Calculate Relative maxima, relative minima, absolute maxima, absolute minima with suitable example.	

3	Implement Newton's method to find approximate solution of an equation.
4	Implement Solution of a first order first degree differential equation, Euler's method
5	Calculate partial derivatives of given suitable functions .
6	Implement any Problems based on binomial distribution & Property Plotting.
7	Implement any Problems based on normal distribution & Property Plotting.
8	Calculate and Plot pdf, cdf, pmf, for discrete and continuous distribution .
9	Implement t test, normal test, F test with suitable example.
10	Implement Non parametric tests- I & II .
11	Implement Post-hoc analysis of one-way analysis.
12	Write a program to implement Abstract Data Types (ADT).
13	Write a program to implement Singly Linked list with insertion, deletion, traversal operations.
14	Write a program to implement Doubly Linked list with insertion, deletion, traversal operations.
15	Write a program to implement Stack with insertion, deletion, traversal operations.
16	Write a program to implement Queue with insertion, deletion, traversal operations.
17	Write a program to implement Priority Queue with insertion, deletion, traversal operations.
18	Write a program to implement Binary Tree with insertion, deletion, traversal operations.
19	Write a program to implement Huffman Coding.
20	Write a program to implement Graph with insertion, deletion, traversal operations.
21	Write a program to implement Travelling Salesman Problem.

***Learning Resources recommended***

**Textbooks:**

- Data Structure and algorithm Using Python, Rance D. Necaie, 2016 Wiley India Edition
- Data Structure and Algorithm in Python, Michael T. Goodrich, Robertom Tamassia, M. H. Goldwasser, 2016 Wiley India Edition

**Additional References:**

- Data Structure and Algorithmic Thinking with Python- Narasimha Karumanchi, 2015, Careermonk Publications
- Fundamentals of Python: Data Structures, Kenneth Lambert, Delmar Cengage Learning

***Syllabus of Courses of B.Sc. Computer Science  
Programme at Semester II  
with Effect from the Academic Year 2023-2024  
Department Specific Courses (DSC)  
Open Elective***

<b>Name of the Course</b>	<b>Advanced Excel</b>
Course Code	USOE208
Class	FYBSC
Semester	II
No of Credits	2
Nature	Theory
Type	Open Elective
Employability/ entrepreneurship/ skill development	This paper focuses on advanced statistical techniques and its computation programmatically. It gives best opportunity in the field of data science.

***Advanced Excel  
Modules at a Glance***

<b>Sr. No.</b>	<b>Modules</b>	<b>No. of Lectures</b>
1	Introduction to Excel, Understanding and Using Basic Functions	10
2	Proofing and Formatting, Printing Workbooks , Advance Paste Special Techniques, Time and Date Functions	10
3	Filtering and Sorting, Pivot Tables, Charts, Introduction to Excel	10
<b>Total</b>		<b>30</b>

***Course Outcomes***

- The learner will be able to
1. Will have in depth understanding of MS Excel
  2. Organize data for analysis.
  3. Draw graphical representation of data.

Sr. No.	Modules / Units
1	<b>Introduction to Excel, Understanding and Using Basic Functions (10 Lectures)</b>
	Introduction to Excel : A description of the interface, the menu system, and the fundamentals of spreadsheets, Various methods of selecting, ShortCut Keys ,Personalizing Excel: Changing Excel’s Default Options Using AutoCorrect and Customizing It Customizing the Ribbon Understanding and Using Basic Functions :Using Functions – Sum, Average, Max, Min, Count, Counta ,Text Functions:Upper, Lower, Proper,Left, Mid, Right,Trim, Len, Exact, Concatenate, Find, Substitute Arithmetic Functions SumIf,,SumIfs CountIf, CountIfs AverageIf, AverageIfs
2	<b>Proofing and Formatting, Printing Workbooks , Advance Paste Special Techniques, Time and Date Functions (10 Lectures)</b>
	Proofing and Formatting : Formatting Cells with Number formats, Font formats, Alignment, Borders, Basic conditional formatting Protecting Excel- Excel Security. File Level Protection: Workbook, Worksheet Protection Printing Workbooks: Printing Workbooks: Setting Up Print Area. Customizing Headers & Footers. Designing the structure of a template. Print Titles –Repeat Rows / Columns Advance Paste Special Techniques : Paste Formulas, Paste Formats, Transpose Tables, Paste Validations Time and Date Functions: Today, Now, Date, Date if, DateAdd, Day, Month, Year, Month, Weekday
3	<b>Filtering and Sorting, Pivot Tables, Charts, Introduction to Excel (10 Lectures)</b>
	Filtering and Sorting :Filtering on Text, Numbers & Colors, Sorting Options, Advanced Filters Pivot Tables :Creating Simple Pivot Tables, Classic Pivot table Basic and Advanced Value Field Setting, Calculated Field & Calculated Items, Grouping based on numbers and Dates Charts : Various Charts i.e. Bar Charts / Pie Charts / Line Charts

**Learning Resources recommended****Additional References:**

1. <https://www.w3schools.com/EXCEL/index.php>
2. <https://edu.gcfglobal.org/en/excel/#>
3. <https://www.javatpoint.com/excel-tutorial>
4. <https://www.excel-easy.com/>
5. <https://support.microsoft.com/en-au/office/excel-video-training-9bc05390-e94c-46af-a5b3-d7c22f6990bb>

**Syllabus of Courses of B.Sc. Computer Science  
Programme at Semester II  
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Department Specific Courses (DSC)  
Open Elective**

<b>Name of the Course</b>	<b>Basic Computer System</b>
Course Code	USOE203
Class	FYBSC
Semester	II
No of Credits	2
Nature	Theory
Type	Open Elective
Employability/ entrepreneurship/ skill development	It gives basic computer knowledge and techniques to the students which create a base for employability in various fields.

**Basic Computer System  
Modules at a Glance**

Sr · No ·	Modules	No. of Lectures
1	Introduction to computers	10
2	Computer networking	10
3	The Internet and Internet Services	10
<b>Total</b>		<b>30</b>

**Course Outcomes**

The learner will be able to

1. Develop an understanding of computer networking and internet.
2. Develop skills to use word processing, spreadsheet.

Sr. No.	Modules / Units
1	<b>Introduction to computers (10 Lectures)</b>
	<p><b>Introduction to computers:</b> Overview and functions of a computer system, Input and output devices, Storage devices. Modern computers: The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer &amp; The Super Computer</p> <p><b>Introduction to operating systems:</b> Operating System concept, Windows, Unix/Linux &amp; servers</p> <p><b>Word Processing:</b> Basic Operations, Creating and Editing documents, Formatting documents.</p> <p><b>Spreadsheet:</b> Creating and editing workbook, Organizing and formatting worksheets; Data analysis and management; Using formulas and functions.</p>
2	<b>Computer networking (10 Lectures)</b>
	<p><b>Introduction to networking:</b> Various terminologies Associated hardware devices, gadgets (Router, Switch) tools, services, and resources Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW)</p> <p>Network security: fire walls</p> <p><b>Computer viruses:</b> An overview of Computer viruses: What is a virus? Virus signs, how do they get transmitted? What are the dangers? General Precautions</p>
3	<b>The Internet and Internet Services (10 Lectures)</b>
	<p><b>The Internet and Internet Services:</b> Introduction, History of Internet, Internetworking Protocol, The Internet Architecture, Managing the Internet, connecting to Internet, Internet Connections: Dial-up Access, Leased Line, Integrated Services Digital Network (ISDN), Digital Subscriber Line (DSL), Cable, Modem</p> <p>Internet Address</p> <p><b>Internet Services:</b> World Wide Web (WWW), Web Browser, Uniform Resource Locator (URL), Internet Search Engines, WWW Development Languages, Uses of Internet</p> <p><b>Electronic Mail:</b> E-mail Address, E-mail Message Format, E-mail Services, How E-mail Works File Transfer Protocol (FTP), How FTP Works, Terminal Network (Telnet), News, Internet Relay Chat (IRC), MS Outlook.</p>

### *Learning Resources recommended*

#### **References:**

1. Sinha, P. K., Sinha, P. (2004). Computer Fundamentals. India: BPB Publications.
2. Goel, A. (2010). Computer Fundamentals. India: Pearson Education.
3. Wempen, F. (2014). Computing Fundamentals: Introduction to Computers. Germany: Wiley.



***Syllabus of Courses of B.Sc. Computer Science  
Programme at Semester II  
with Effect from the Academic Year 2023-2024  
Department Specific Courses (DSC)  
Skill Enhancement Course***

<b>Name of the Course</b>	Linux Practical
Course Code	USCS207
Class	FYBSC
Semester	II
No of Credits	2
Nature	SEC- Linux Practical
Type	SEC-Mandatory
Employability/ entrepreneurship/ skill development	<p>This syllabus will help to train students in fundamental skills and build-up sustainable interest in Linux Operating System. It will improve the necessary knowledge base to understand Linux Operating System and its practical implementation, it will also help to develop Linux based solutions for real life problems.</p> <p>The said course requires theory as well as practical sessions. Theoretical session will be covered during the practical session. Visual appearance of theory topic will be given during practical work. Commands and scripts are taken in the form of practical sessions.</p> <p>Previously no internal marking is defined for practical courses. This course will take a 60:40 evaluation pattern where 60 marks for practical examination at the end of semester and 40 marks will be used for continuous internal evaluation form.</p>
<b><i>Course Outcomes</i></b>	
<ol style="list-style-type: none"> <li>1. To learn basic concepts of Linux in terms of operating system</li> <li>2. To learn use of various shell commands with regular expressions</li> <li>3. To set Linux Environment variables and learn setting file permissions to maintain Linux security implementation</li> <li>4. To learn various editors available in Linux OS</li> <li>5. To learn shell scripting.</li> </ol>	

Course Code	Course Title		Credits
USCS207	Linux Practical		02
<p><b>Note: The following practical should be implemented using virtual box and Ubuntu</b>  <b>Link: for virtual box: <a href="https://www.virtualbox.org/wiki/Downloads">https://www.virtualbox.org/wiki/Downloads</a></b>  <b>For Ubuntu OS : <a href="https://ubuntu.com/desktop">https://ubuntu.com/desktop</a></b>  <b>Minimum 20 practicals should be submitted as Journal work.</b></p>			
Sr. No.	Concept	Practical Title	
1	Introduction	Introduction to Linux and its distributions.	
2	Installation	Booting and installing from (USB/DVD)	
3	Managing Desktop	Customize desktop environment by changing different default options like changing default background, themes, and screensavers.	
4	Operations performed on a Linux	Administering system and User setting-Screen Resolution, Time Settings etc.	
5	Becoming Ubuntu power user	Learning Unity keyboard Using the Terminal	
6	File System Commands	touch, help, man, more, less, pwd, cd, mkdir, rmdir, ls, find, ls	
7	File handling Commands	cat, cp, rm, mv, more, file, wc, od, cmp, diff, comm,	
8	Zippping Com mands	gzip and gunzip, zip and unzip, tar	
9	Advanced File handling Commands	chmod, chown, chgrp, , ln, umask,, chmod, chgrp, chown, etc	
10	Generl purpoe utility Commans	cal, date, echo, man, printf, passwd, script, who, uname, tty, stty	
11	Simple Filters and I/O redirection	head, tail, cut paste, sort, grep family, tee, uniq, tr, etc.	
12	Networking Commands	who, whoami, ping, telnet, ftp, ssh, etc	
13	Shell scripting I	Conditions (for loop, until loop and while loop) arithmetic operations, examples	
14	Shell scripting II	Redirecting Input / Output in scripts, creating your own Redirection	
15	Editors	vi, sed, awk	
16	Working and Managing with processes	sh, ps, kill, nice, at and batch etc.	
17	Shell scripting III	Defining variables, reading user input, exit and exit status	

		commands
18	Shell scripting IV	expr, test, [], if conditional, logical operators
19	Use of Functions	Create a function, pass value to a function and return a value from a function.
20	Maths scripting	Pipes performing maths

### ***Learning Resources recommended***

#### **Textbooks:**

1. "Linux Command line and Shell Scripting Bible", Richard Blum, Wiley India.
2. "Unix: Concepts and Applications", Sumitabha Das, 4th Edition, McGraw Hill.
3. "Official Ubuntu Book", Matthew Helmke & Elizabeth K. Joseph with Jose Antonio Rey and Philips Ballew, 8th Ed.

#### **Additional References:**

1. "Linux Administration: A Beginner's Guide", Fifth Edition, Wale Soyinka, Tata McGraw-Hill, 2008.
2. "Linux: Complete Reference", Richard Petersen, 6th Edition, Tata McGraw-Hill
3. "Beginning Linux Programming", Neil Mathew, 4th Edition, Wiley Publishing, 2008.

**Syllabus of Courses of B.Sc. Computer Science**  
**Programme at Semester II**  
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**Department Specific Courses (DSC)**  
**AEC**

Name of the Course	Content Writing
Course Code	USCS208
Class	FYBSC
Semester	II
No of Credits	2
Nature	Theory
Type	AEC
Employability/ entrepreneurship/ skill development	<p>With the advent of the internet, content writing has become a very lucrative and promising career. The course is designed to equip students to comprehend, refine, and enhance their writing abilities so that they may become proficient web content developers. The course aims to prepare students to enter the industry with enhanced skill and substantial competence.</p> <p>Tools for content writing, developing contents on web sites are curtain from unit I as these points will be covered in Unit II and Unit III. Also grammatical errors and legal English vocabulary are eliminated to cope up with 30 hours since the course originally designed for 45 hours.</p>

**Content Writing**  
**Modules at a Glance**

Sr. No.	Modules	No. of Lectures
1	Basics of Content writing , Best Practices for Writing for the Web	10
2	Social Media Writing, Info graphics	10
3	Schema refinement and Normal forms, Database Protection , Transaction control commands	10
<b>Total</b>		<b>30</b>

**Course Outcomes**

The learner will be able to

1. To introduce students to the concepts of content writing.
2. To connect them with various writing and editing styles and techniques.
3. To help them develop their creative abilities.
4. To improve the learners' employability

Sr. No.	Modules / Units
1	<b>Basics of Content writing, Best Practices for Writing for the Web (10 Lectures)</b>
	Basics of Content writing: Introduction to Content Writing, Learning Tone in Writing and Its Types, Comprehending style in writing and its Types. Best Practices for Writing for the Web: Making our story Elegant, Professional, Write with an Attitude, Keep Verbs Active, List Items, Title and Subtitle, Organize for Your Audience.
2	<b>Social Media Writing, Info graphics (10 Lectures)</b>
	Social Media Writing: Writing for Twitter, writing with Hashtags, Writing Social Media with Humor, writing for Facebook, writing for LinkedIn, Writing Your LinkedIn Profile, writing for Email, Writing Landing Pages, Writing Headlines, writing a Home Page, Writing the About Us Page, Writing Better Blog Posts, Writing Annual Reports. Infographics : Visual Communication-What Are Infographics?, The Science of Visualization, Creating Infographics-Purpose, The Art of Observation, Processing Your Ideas, Designing Your Infographics, Publishing Your Infographics.
3	<b>Content Tools, Ethical and Legal aspects of content writing (10 Lectures)</b>
	Content Tools.: Research and Knowledge Management Tools, Writing Tools, Productivity Tools, Editing Tools, Non-Text Writing Tools, Image Sources, Tools for Content Writing. Ethical and Legal aspects of content writing : Learn Legal English, Learn Legal Vocabulary In Legal Writing, IPR Laws, and Copywriting, Plagiarism laws in Content Writing.

### *Learning Resources recommended*

#### **Textbooks:**

1. Content Writing Handbook, Author:Kounal Gupta, 2020, Henry Harvin.
2. Feldar, Lynda. Writing for the Web: Creating Compelling Web Content Using Words, Pictures, and Sound. New Riders, CA, USA, 2011

#### **Additional References:**

1. Everybody Writes: Your Go-To Guide to Creating Ridiculously Good Content Paperback Ann Handley Pan Macmillan India 2016
2. The Power of Infographics: Using Pictures to Communicate and Connect With Your Audiences Paperback – 15 June 2012 Mark Smiciklas
3. Law Relating to Intellectual Property Rights Book by V. K. Ahuja, 2017

#### **Web Resources:**

1. <https://www.locationrebel.com/b2b-writing/>
2. <https://www.mindler.com/blog/how-to-become-a-content-writer-in-india/>
3. [https://study.com/articles/What\\_is\\_a\\_Content\\_Writer.html](https://study.com/articles/What_is_a_Content_Writer.html)<https://www.mondaq.com/india/contracts-and-commercial-law/445620/legal-contractsagreements-drafting-and-legal-vetting>
4. <https://www.crazyegg.com/blog/copywriting/>

***Syllabus of Courses of B.Sc. Computer Science  
Programme at Semester II  
with Effect from the Academic Year 2023-2024  
Department Specific Courses (DSC)  
VEC***

<b>Name of the Course</b>	<b>Green Computing II</b>
Course Code	USCS209
Class	FYBSC
Semester	II
No of Credits	2
Nature	Theory
Type	VEC
Employability/ entrepreneurship/ skill development	This course is a continuation of the Semester I paper. Topics like the role of IT and managing green IT are introduced. These topics will make awareness about green IT among students and develop an era of Computer Systems which are less harmful to the environment.

***Green Computing II  
Modules at a Glance***

<b>Sr. No.</b>	<b>Modules</b>	<b>No. of Lectures</b>
1	Green Networks and Communications, Enterprise Green IT Strategy	10
2	Sustainable Information Systems and Green Metrics, Enterprise Green IT Readiness	10
3	Sustainable IT Services, Green Enterprises and the Role of IT, Managing Green IT	10
<b>Total</b>		<b>30</b>

***Course Outcomes***

The learner will be able to

1. Learn about green IT can be achieved in and by hardware, software, network communication and data center operations.
2. Understand the strategies, frameworks, processes and management of green IT

Sr. No.	Modules / Units
1	<b>Green Networks and Communications, Enterprise Green IT Strategy</b> <b>(10 Lectures)</b>
	Green Networks and Communications : Introduction, Objectives of Green Network Protocols, Green Network Protocols and Standards Enterprise Green IT Strategy: Introduction, Approaching Green IT Strategies, Business Drivers of Green IT Strategy, Business Dimensions for Green IT Transformation, Organizational Considerations in a Green IT Strategy, Steps in Developing a Green IT Strategy, Metrics and Measurements in Green Strategies.
2	<b>Sustainable Information Systems and Green Metrics, Enterprise Green IT Readiness</b> <b>(10 Lectures)</b>
	Sustainable Information Systems and Green Metrics: Introduction, Multilevel Sustainable Information, Sustainability Hierarchy Models, Product Level Information, Individual Level Information, Functional Level Information, Organizational Level Information, Measuring the Maturity of Sustainable ICT Enterprise Green IT Readiness: Introduction, Readiness and Capability, Development of the G-Readiness Framework, Measuring an Organization's G-Readiness.
3	<b>Sustainable IT Services, Green Enterprises and the Role of IT, Managing Green IT</b> <b>(10 Lectures)</b>
	Sustainable IT Services: Creating a Framework for Service Innovation: Introduction, Factors Driving the Development of Sustainable IT, Sustainable IT Services (SITS), SITS Strategic Framework Green Enterprises and the Role of IT : Introduction, Organizational and Enterprise Greening, Information Systems in Greening Enterprises, Greening the Enterprise: IT Usage and Hardware, Inter-organizational Enterprise Activities and Green Issues Managing Green IT : Introduction, Strategizing Green Initiatives, Implementation of Green IT, Information Assurance, Communication and social media, case study

### *Learning Resources recommended*

#### **Text book:**

1. Harnessing Green IT: Principles and Practices, San Murugesan, G. R. Ganadharan, Wiley & IEEE.

#### **Additional References:**

1. Green IT, Deepak Shikarpur, Vishwkarma Publications, 2014
2. Green Communications: Principles, Concepts and Practice- Samdanis et al, J. Wiley Green IT for Sustainable Business Practice: An ISEB Foundation Guide, Mark G. O'Neill, The Chartered Institute for IT, 2010

The Chairperson,  
BoS of Computer Science

**Affiliated to  
University of Mumbai**



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

**Bachelor of Science (B.Sc)  
Programme-Computer Science  
Three Year Integrated Programme  
Six Semesters**

**Course Structure**

**S.Y.B.Sc. Sem-III & IV**

**Choice Based Credit System (CBCS)  
Implementation Year - 2023-24**



## Preamble

The revised and restructured curriculum for the Three-year integrated course is systematically designed considering the Autonomy constraints. The focus is on current industry needs in terms of skills sets demanded under the new technological environment. It also endeavors to align the programme structure and course curriculum with student aspirations and corporate expectations. The curriculum is more contextual, industry friendly and suitable to cater the needs of society and nation in the present day context.

The Core Subjects offer to develop strong theoretical foundations in Computer Science to build computational thinking, analytical, and problem solving skills. A Principle of Operating Systems course provides an overview of computer operating systems, their functionalities, processes, and computing resource management. Linear Algebra course covers concepts crucial to many areas of computer science, relevant to Linear Algebra concepts like Vectors, Vector space, Matrix, Dimension, Gaussian elimination, etc. Data Structures course provides an understanding of different types of data structures and how to use them per the requirements of a given application. The Advanced Database Concepts course touches on the security, recovery, and transaction aspects of databases. Theory of Computation course helps to develop capabilities to design and develop formulations for computing models and identify its applications in diverse areas. Computer Networks courses include topics such as application layer protocols, Internet protocols, network interfaces, local and wide area networks, wireless networks, bridging and routing, among other current topics. The Software Engineering course embodies an engineering approach to the development of software. It discusses the nature of software and software projects, software development models, software process maturity, project planning, management, and estimations along with topics on software testing and quality assurance. The course on IoT Technologies will definitely open a future area as Embedded Engineer, involvement in IoT projects, Robotics and many more.

Skill Enhancement courses such as Java based Application Development, Web Technologies, Android Application Development and Advanced Application Development cater to present day needs of web and mobile based platforms and applications. These courses aim to produce skilled graduates with a creative mind-set who can recognize a computational problem either in the IT industry or society, and develop effective solutions.

The General Elective courses offer the students the option to explore disciplines of interest beyond the choices they make in Core and Discipline Specific Elective papers. The course on Creative Content Writing prepares students to comprehend, refine, and enhance their writing abilities and enter the industry with enhanced skill and substantial competence. The course on Green Technologies emphasizes the use of principles and practices of green services and regulatory standards for addressing the carbon issues and related concerns. The Research Methodology instills basic research skills for students who wish to pursue a research or an academic career. Management & Entrepreneurship course aims to focus on giving students the business management and innovation skills required to succeed in a startup.

We sincerely believe that the student enrolled into this programme will get a very strong foundation and exposure to basics, advanced and emerging trends of the subject.

We wholeheartedly thank all experts who shared their valuable feedback and suggestions in order to improvise the contents; we have sincerely attempted to incorporate each of them. We further thank the Chairperson and members of the Board of Studies for having faith in us.

Special thanks to the Department of Computer Science, Gogate Jogalekar College(Autonomous), Ratnagiri and all honorable members of the Board of Studies of Computer Science, who volunteered or have directly or indirectly, helped design certain specialized courses and the syllabus as a whole.

Name of Programme	<b>B Sc Computer Science</b>
Level	UG
No of Semesters	06
Year of Implementation	<b>2023</b>
Programme Specific Outcomes (PSO)	<ol style="list-style-type: none"> <li>1. To formulate, model, design solutions, procedure and to use software tools to solve real world problems.</li> <li>2. To design and develop computer programs/computer - based systems in the areas such as networking, web design, security, cloud computing, IoT, data science and other emerging technologies.</li> <li>3. To familiarize with the modern-day trends in industry and research based settings and thereby innovate novel solutions to existing problems.</li> <li>4. To apply concepts, principles, and theories relating to computer science to new situations.</li> <li>5. To use current techniques, skills, and tools necessary for computing practice</li> <li>6. To apply standard Software Engineering practices and strategies in real-time software project development</li> <li>7. To pursue higher studies of specialization and to take up technical employment.</li> <li>8. To work independently or collaboratively as an effective team member on a substantial software project.</li> <li>9. To communicate and present their work effectively and coherently.</li> <li>10. To display an ethical code of conduct in usage of Internet and Cyber systems.</li> <li>11. To engage in independent and life-long learning in the background of rapid changing IT industry</li> </ol>
Relevance of PSOs to the local, regional, national, and global developmental needs (200 words)	<p>The revised and restructured curriculum for the Three-year integrated course is systematically designed considering the National Education Policy(NEP) along with the Autonomy constraints. The focus is on current industry needs interms of skills sets demanded under the new technological environment. It also endeavors to align the programme structureand course curriculum with student aspirations and corporate expectations. The curriculum is more contextual, industry friendly and suitable to cater the needs of society and nation in the present day context.</p> <p>As the world is heading towards digitalization, the syllabus is framed by concentrating on such needs. With the help of basic programming skills and designing technique, a student is able to make small workable projects which can be beneficial for local vendors. To make these projects strong, various concepts of project management, database management are involved. Various industries need IT support at loca or across the country. Students having the skills of computers are able to sustain in the IT industry at various locations.</p> <p>Development in thought processes can lead one in a research area to contribute to an upcoming trend. Students can become</p>

	<p>entrepreneurs since the techniques of management and entrepreneurship are taught to them.</p> <p>Due to the learning of cyber safety, ethical hacking, students can become ethical hackers where students can contribute to national security. Students can make community awareness due to learning about cyber safety.</p> <p>Continuous growth in trends requires students updated which will help them mercurial. This will help in sustaining the IT industry and become employable.</p>
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**S.Y.B.Sc. Computer Science Syllabus**  
**Choice Based Credit System (CBCS)**  
**Implementation Year 2023-2024**

<b>Semester – III</b>				
<b>Course Code</b>	<b>Course Type</b>	<b>Course Title</b>	<b>Credits</b>	<b>Lectures/Week</b>
USCS301	Core Subject	Principles of Operating Systems	2	3
USCSP301	Core Subject Practical	Principles of Operating Systems – Practical	1	3
USCS302	Core Subject	Linear Algebra	2	3
USCSP302	Core Subject Practical	Linear Algebra – Practical	1	3
USCS303	Core Subject	Data Structures	2	3
USCSP303	Core Subject Practical	Data Structures – Practical	1	3
USCS304	Core Subject	Advanced Database Concepts	2	3
USCSP304	Core Subject Practical	Advanced Database Concepts – Practical	1	3
USCS305	Skill Enhancement Course (SEC)	Java based Application Development	2	3
USCSP305	Skill Enhancement Course (SEC) Practical	Java based Application Development – Practical	1	3
USCS306	Skill Enhancement Course (SEC)	Web Technologies	2	3
USCSP306	Skill Enhancement Course (SEC) Practical	Web Technologies – Practical	1	3
USCS3071	Generic Elective	Creative Content Writing	2	3
USCS3072	Generic Elective	Green Technologies	2	3

*\* Any one Generic Elective has to be selected by the student.*

**S.Y.B.Sc. Computer Science Syllabus**  
**Choice Based Credit System (CBCS)**  
**Implementation Year 2023-2024**

<b>Semester – IV</b>				
<b>Course Code</b>	<b>Course Type</b>	<b>Course Title</b>	<b>Credits</b>	<b>Lectures/Week</b>
USCS401	Core Subject	Theory of Computation	2	3
USCSP401	Core Subject Practical	Theory of Computation – Practical	1	3
USCS402	Core Subject	Computer Networks	2	3
USCSP402	Core Subject Practical	Computer Networks – Practical	1	3
USCS403	Core Subject	Software Engineering	2	3
USCSP403	Core Subject Practical	Software Engineering – Practical	1	3
USCS404	Core Subject	IoT Technologies	2	3
USCSP404	Core Subject Practical	IoT Technologies – Practical	1	3
USCS405	Skill Enhancement Course (SEC)	Android Application Development	2	3
USCSP405	Skill Enhancement Course (SEC) Practical	Android Application Development – Practical	1	3
USCS406	Skill Enhancement Course (SEC)	Advanced Application Development	2	3
USCSP406	Skill Enhancement Course (SEC) Practical	Advanced Application Development – Practical	1	3
USCS4071	Generic Elective*	Research Methodology	2	3
USCS4072	Generic Elective*	Management & Entrepreneurship	2	3

*\* Any one Generic Elective has to be selected by the student.*

**Revised Syllabus of Courses of B.Sc. Computer Science Programme at Semester III**  
**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Principles of Operating Systems</b>
Course Code (refer to student handbook)	<b>USCS301</b>
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Nomenclature:** Principles of Operating Systems

**Course Outcomes:**

- To learn basic concepts and structure of operating systems
- To learn about process and synchronization in operating system level
- To learn CPU scheduling algorithms
- To learn Memory and File system management

**After successful completion of this course, students would be able to**

- Work with any type of operating system
- Handle threads, processes, process synchronization
- Implement CPU scheduling algorithms
- Understand the background role of memory management
- Design files system.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Introduction to Operating-Systems</b>	Definition of Operating System, Operating System's role, Operating-System Operations, Functions of Operating System, Computing Environments	<b>15</b>
	<b>Operating-System Structures:</b>	Operating-System Services, User and Operating-System Interface, System Calls, Types of System Calls, Operating-System Structure	
	<b>Processes:</b>	Process Concept, Process Scheduling, Operations on Processes, Interprocess Communication	
	<b>Threads:</b>	Overview, Multicore Programming, Multithreading Models	
<b>II</b>	<b>Process Synchronization:</b>	General structure of a typical process, race condition, The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Mutex Locks, Semaphores, Classic Problems of Synchronization, Monitors	<b>15</b>
	<b>CPU Scheduling:</b>	Basic Concepts, Scheduling Criteria, Scheduling Algorithms (FCFS, SJF, SRTF, Priority, RR, Multilevel Queue Scheduling, Multilevel Feedback Queue Scheduling), Thread Scheduling	

	<b>Deadlocks:</b>	System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock	
<b>III</b>	<b>Main Memory:</b>	Background, Logical address space, Physical address space, MMU, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table	<b>15</b>
	<b>Virtual Memory</b>	Background, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing	
	<b>Mass-Storage Structure</b>	Overview, Disk Structure, Disk Scheduling, Disk Management	
	<b>File-System Interface</b>	File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing	
	<b>File-System Implementation</b>	File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management	

**Textbook(s):**

1. Abraham Silberschatz, Peter Galvin, Greg Gagne, Operating System Concepts, Wiley, 2021

**Additional Reference(s):**

1. Achyut S. Godbole, AtulKahate, Operating Systems, Tata McGraw Hill, 2017
2. Naresh Chauhan, Principles of Operating Systems, Oxford Press, 2014
3. Andrew S Tanenbaum, Herbert Bos, Modern Operating Systems, 4e Fourth Edition, Pearson Education, 2016

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b> (Modularobject-orienteddynamiclearning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

## Principles of Operating Systems – Practical

Name of the Course	<b>Principles of Operating Systems – Practical</b>
Course Code (refer to student handbook)	<b>USCSP301</b>
Class	S.Y.B.Sc.
Semester	III
No of Credits	1
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

### Curriculum:

**Lecture/ week: 3**

<b>The following practicals will be implemented using JAVA Minimum 8 practicals to be completed as a journal work.</b>	
Sr. No.	Practical Title
Practical -1	Process Communication: a. Write a program to give a solution to the producer–consumer problem using shared memory. Write a program to give a solution to the producer–consumer problem using message passing.
Practical -2	Threads: a. Write a program to work with a single thread. b. Write a program to work with multi threads. The Fibonacci sequence is the series of numbers 0, 1, 1, 2, 3, 5, 8, ... Formally, it can be expressed as: fib0 = 0, fib1 = 1, fibn = fibn-1 + fibn-2. Write a multithreaded program that generates the Fibonacci sequence.
Practical -3	Synchronization: a. Write a program to give a solution to the Bounded buffer problem. Write a program to give a solution to the readers–writers problem.
Practical -4	Write a program that implements FCFS scheduling algorithm.
Practical -5	Write a program that implements (with no preemption) scheduling algorithm.
Practical -6	Write a program that implements RR scheduling algorithm.
Practical -7	Write a program that implements the banker’s algorithm
Practical -8	Write a program that implements the FIFO page-replacement algorithm.
Practical -9	Write a program that implements the LRU page-replacement algorithm.
Practical -10	Write a program to design a File System.



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

<b>Sr No</b>	<b>Criterion</b>	<b>Marks</b>
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks****Duration: 1 hr**

<b>Sr No</b>	<b>Criterion</b>	<b>Marks</b>
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Linear Algebra</b>
Course Code (refer to student handbook)	<b>USCS302</b>
Class	S.Y.B.Sc
Semester	III
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100words	—

**Nomenclature:** Linear Algebra**Course Outcomes:**

- To offer the learner the relevant Linear Algebra concepts through Computer Science applications.
- To interpret existence and analyze the solution set of a system of linear equations.
- To formulate, solve, apply, and interpret properties of linear systems.
- To learn about the concept of linear independence of vectors over a field, and the dimension of a vector space.
- To interpret basic concepts of linear transformations, dimension, matrix representation of a linear transformation, and the change of coordinate matrix.

**After successful completion of this course, students would be able to**

- Appreciate the relevance and applications of Linear Algebra in the field of Computer Science.
- Understand the concepts through program implementation.
- Instill computational thinking while learning linear algebra.
- Express clear understanding of the concept of a solution to a system of equations.
- Find eigenvalues and corresponding eigenvectors for a square matrix.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
I	<b>Field</b>	Introduction to complex numbers, complex numbers in Python, abstracting over fields, Playing with GF (2).	15
	<b>Vectors:</b>	Vectors are functions, Vector addition, Scalar-vector multiplication, combining vector addition and scalar multiplication, Dictionary-based representations of vectors, Dot-product, Solving a triangular system of linear equations, Support Vector Machine – Introduction, Mechanism.	
	<b>The Vector Space</b>	Linear combination, Span, The geometry of sets of vectors, Vector spaces, Linear systems, homogeneous and otherwise	

<b>II</b>	<b>Matrix</b>	Matrices as vectors, Column space and row space, Matrix-vector and vector-matrix multiplication in terms of linear combinations, Matrix-vector multiplication in terms of dot-products, Null space, Computing sparse matrix-vector product, Linear functions, Matrix-matrix multiplication, Inner product and outer product, From function inverse to matrix inverse	<b>15</b>
	<b>Basis</b>	Coordinate systems, two greedy algorithms for finding a set of generators, Linear dependence, Basis, Unique representation, Change of basis, first look, Computational problems involving finding a basis	
	<b>Dimension</b>	Dimension and rank, Direct sum, Dimension and linear functions, The annihilator	
	<b>Gaussian elimination</b>	Echelon form, Gaussian elimination over GF(2), Solving a matrix-vector equation using Gaussian elimination.	
<b>III</b>	<b>Inner Product</b>	The inner product for vectors over the reals, Orthogonality.	<b>15</b>
	<b>Orthogonalization</b>	Projection orthogonal to multiple vectors, projecting orthogonal to mutually orthogonal vectors, Building an orthogonal set of generators, orthogonal complement.	
	<b>Eigen values and Eigenvectors</b>	Characteristic Polynomials of degree 2 and 3, Eigenvalues and eigenvectors, Properties of eigen values and eigenvectors, Cayley–Hamilton Theorem, Minimal Polynomial. Coordinate representation in terms of eigenvectors, The Internet worm, Markov Chains, Google Page Rank algorithm.	

**Learning Resources recommended:****Textbooks:**

1. Coding the Matrix Linear Algebra through Applications to Computer Science, First Edition,  
Philip N. Klein, Newtonian Press 2013
2. Schaum's Outline of Linear Algebra, Sixth Edition by Seymour Lipschutz, Marc Lipson,  
McGraw Hill 2017

**Additional References:**

1. Linear Algebra and Probability for Computer Science Applications, First Edition, Ernest Davis, A K Peters/CRC Press, 2012.
2. Linear Algebra and Its Applications, Gilbert Strang, Cengage Learning, 4th Edition, 2007
3. Linear Algebra and Its Applications, David C Lay, Pearson Education India; 3rd Edition, 2002
4. Introduction to Information Retrieval, Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Cambridge University Press, 2008.
5. Computer Networking With Internet Protocols and Technology, William Stallings, Pearson Education  
India, 2013.

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular Object-oriented dynamic learning environment)</li> <li>The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

**Linear Algebra – Practical**

Name of the Course	<b>Linear Algebra – Practical</b>
Course Code (refer to student handbook)	<b>USCSP302</b>
Class	SYBSc
Semester	III
No of Credits	1
Nature	Practical
Type (applicable to NEP only)	–
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum: Lecture/ week: 3**

<b>The following practicals will be implemented using Python Minimum 8 practicals to be completed as a journal work.</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
Practical -1	Write a program which demonstrates the following: <ul style="list-style-type: none"> <li>• Addition of two complex numbers</li> <li>• Displaying the conjugate of a complex number</li> <li>• Plotting a set of complex numbers</li> <li>• Creating a new plot by rotating the given number by a degree 90, 180, 270 degrees and also by scaling by a number <math>a = 1/2</math>, <math>a = 1/3</math>, <math>a = 2</math> etc.</li> </ul>
Practical -2	Write a program to do the following: <ul style="list-style-type: none"> <li>• Enter a vector <math>u</math> as a <math>n</math>-list</li> <li>• Enter another vector <math>v</math> as a <math>n</math>-list</li> <li>• Find the vector <math>au + bv</math> for different values of <math>a</math> and <math>b</math></li> <li>• Find the dot product of <math>u</math> and <math>v</math></li> </ul>
Practical -3	Vector Applications: Classify given data using support vector machines (SVM)
Practical -4	Basic Matrix Operations: <ul style="list-style-type: none"> <li>• Matrix Addition, Subtraction, Multiplication</li> <li>• Check if matrix is invertible.</li> <li>• If yes then find Inverse</li> </ul>
Practical -5	Write a program to convert a matrix into its row echelon form. (Order 2). Write a program to find rank of a matrix.
Practical -6	Basic Matrix Application – I Representation of Image in Matrix Format and Image Transformations
Practical -7	Basic Matrix Application – II Perform Image addition, multiplication and subtraction
Practical -8	Write a program to do the following: <ul style="list-style-type: none"> <li>• Enter a vector <math>b</math> and find the projection of <math>b</math> orthogonal to a given vector <math>u</math>.</li> <li>• Find the projection of <math>b</math> orthogonal to a set of given vectors</li> </ul>
Practical -9	Write a program to calculate eigen value and eigenvector (Order 2 and 3)
Practical -10	Implement Google's Page rank algorithm.

**Learning Resources recommended:**

1. Coding the Matrix Linear Algebra through Applications to Computer Science, First Edition, Philip N. Klein, Newtonian Press 2013
2. Schaum's Outline of Linear Algebra, Sixth Edition by Seymour Lipschutz, Marc Lipson, McGraw Hill 2017

**Additional References:**

1. Linear Algebra and Probability for Computer Science Applications, First Edition, Ernest Davis, A K Peters/CRC Press, 2012.
2. Linear Algebra and Its Applications, Gilbert Strang, Cengage Learning, 4th Edition, 2007
3. Linear Algebra and Its Applications, David C Lay, Pearson Education India; 3rd Edition, 2002
4. Introduction to Information Retrieval, Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Cambridge University Press, 2008.
5. Computer Networking With Internet Protocols and Technology, William Stallings, Pearson Education India, 2013.

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

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks****Duration: 1 hr**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Data Structures</b>
Course Code (refer to student handbook)	<b>USCS303</b>
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Nomenclature:** Data Structures**Course Outcomes:**

- To introduce data abstraction and data representation in memory
- To describe, design and use of elementary data structures such as stack, queue, linked list, tree and graph
- How and why different data structures are used for different types of problems.

**After successful completion of this course, students would be able to-**

- Create different types of data structures.
- Understand which data structure to be used based on the type of the problem.
- Apply combined knowledge of algorithms and data structures to write highly effective programs in various domains.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Abstract data Type</b>	Different Data Types, different types of data structures & their classifications, Introduction to ADT, Creating user-specific ADT	<b>15</b>
	<b>Linked Structures</b>	ADT for linked list, Advantages & Disadvantages, Singly Linked List-Traversing, Searching, Prepending and Removing Nodes, applications of linked list like polynomial equation	
	<b>Stacks</b>	Stack ADT for Stack, Advantages & Disadvantages, Applications of stack like balanced delimiter, prefix to postfix notation	
	<b>Queues</b>	Queue ADT, Advantages & Disadvantages, linked representations. Circular Queue operations, Dequeues, applications of queue like job scheduling queues	
<b>II</b>	<b>Doubly Linked list</b>	ADT of doubly linked list, Advantages & Disadvantages, Insertion and deletion of nodes at various positions	<b>15</b>
	<b>Trees</b>	ADT for Tree Structure. Advantages & disadvantages, Binary Tree-Properties, Implementation and Traversals, Binary Search Tree, Balanced BST, Threaded Binary Trees, AVL Trees, Applications of Tree like Huffman Coding	

	<b>Priority Queues &amp; Heaps</b>	Priority Queue, Priority Queue ADT, Advantages and Disadvantages, Applications, Heaps, types of heaps, Heapifying the element	
<b>III</b>	<b>Graph</b>	Introduction, Graph ADT, Advantages and Disadvantages, Graph Representation using adjacency matrix and adjacency list, Graph operations like insertion and deletion of nodes, Graph Traversals using BFS & DFS, Applications of Graphs like shortest path algorithms,	<b>15</b>
	<b>Hashing</b>	Hash Table ADT, Advantages & Disadvantages, Concept of hashing, hash table, hash functions, collision, collision avoidance techniques, Applications of hashing	

**Learning Resources recommended:****Textbooks:**

1. Introduction to Algorithm, Thomas H Cormen, PHI
2. Data Structures And Algorithms Made Easy, NarasimhaKarumanchi, 2021

**Additional References:**

1. Fundamentals of Computer Algorithms, SartajSahni and SanguthevarRajasekaran Ellis Horowitz, Universities Press, 2018
2. Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Wiley, 2016

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modularobject-orienteddynamiclearning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15



**Data Structures – Practical**

Name of the Course	<b>Data Structures – Practical</b>
Course Code (refer to student handbook)	<b>USCSP303</b>
Class	SYBSc
Semester	III
No of Credits	1
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:****Lecture/ week : 3**

<b>The following practicals will be implemented using Python Minimum 8 practicals to be completed as a journal work.</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
Practical -1	Write a program to implement Abstract Data Types (ADT)
Practical -2	Write a program to implement a Singly Linked list with insertion, deletion, traversal operations.
Practical -3	Write a program to implement Doubly Linked list with insertion, deletion, traversal operations
Practical -4	Write a program to implement Stack with insertion, deletion, traversal operations
Practical -5	Write a program to implement Queue with insertion, deletion, traversal operations
Practical -6	Write a program to implement Priority Queue with insertion, deletion, traversal operations
Practical -7	Write a program to implement Binary Tree with insertion, deletion, traversal operations
Practical -8	Write a program to implement Huffman Coding
Practical -9	Write a program to implement Graph with insertion, deletion, traversal operations
Practical -10	Write a program to implement Travelling Salesman Problem
Practical -11	Write a program to create basic Hash Table for insertion, deletion, traversal operations(assume that there are no collisions)
Practical -12	Write a program to create hash table to handle collisions using overflow chaining

**Learning Resources recommended:**

1. Introduction to Algorithm, Thomas H Cormen, PHI
2. Data Structures And Algorithms Made Easy, NarasimhaKarumanchi, 2021

**Additional References:**

1. Fundamentals of Computer Algorithms, SartajSahni and SanguthevarRajasekaran Ellis Horowitz, Universities Press, 2018
2. Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Wiley, 2016

**Evaluation Pattern**

**A. Internal Examination: 20 Marks**

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks**

**Duration: 1 hr**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Advanced Database Concepts</b>
Course Code (refer to student handbook)	<b>USCS304</b>
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Nomenclature: Advanced Database Concepts****Course Outcomes:**

- To develop understanding of concepts and techniques for data management and learn about widely used systems for implementation and usage.
- To develop understanding of Transaction management and crash recovery.
- To develop concepts of programming concepts of databases.

**After successful completion of this course, students would be able to-**

- Create different types of data structures.
- Understand which data structure to be used based on the type of the problem.
- Apply combined knowledge of algorithms and data structures to write highly effective programs in various domains.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
I	<b>Overview of PL/SQL</b>	Advantages of PL/SQL, Main Features of PL/SQL, Architecture of PL/SQL	15
	<b>Fundamentals of PL/SQL</b>	Character Sets, Lexical Units, Declarations, References to Identifiers, Scope and Visibility of Identifiers, Assigning Values to Variables, Expressions, Error-Reporting Functions, Data Types.	
	<b>Control Statements</b>	Conditional Selection Statements, LOOP Statements, Sequential Control Statements, GOTO, and NULL Statements.	
	<b>Sequences</b>	Creating sequences, referencing, altering, and dropping a sequence.	
	<b>Stored Procedures and Functions</b>	Procedures: Types and benefits of stored procedures, creating stored procedures, executing stored procedures, altering stored procedures, viewing stored procedures. Functions: Calling function and recursion function.	

<b>II</b>	<b>Collections and Records</b>	Associative Arrays, Varrays (Variable-Size Arrays), Nested Tables, Collection Constructors, Assigning Values to Collection Variables, Multidimensional Collections, Collection Comparisons, Collection Methods, Collection Types Defined in Package Specifications, Record Variables, Assigning Values to Record Variables.	<b>15</b>
	<b>Error Handling</b>	Compile-Time Warnings, Overview of Exception Handling, Internally Defined Exceptions, Predefined Exceptions, User-Defined Exceptions, Redeclared Predefined Exceptions, Raising Exceptions Explicitly, Exception Propagation, Unhandled Exceptions.	
	<b>Cursors</b>	Overview of Cursor, Types of cursors, Invalid cursor Exception.	
	<b>Static and Dynamic SQL</b>	Description of Static SQL, Cursors Overview, Processing Query Result Sets, Cursor Variables, CURSOR Expressions, Transaction Processing and Control, Autonomous Transactions. Dynamic SQL: Native Dynamic SQL, DBMS_SQL Package, SQL Injection.	
<b>III</b>	<b>Triggers</b>	Overview of Triggers, implementing triggers – creating triggers, Insert, delete, and update triggers, nested triggers, viewing, deleting, and modifying triggers, and enforcing data integrity through triggers.	<b>15</b>
	<b>Packages</b>	Overview of a Package. Need of Packages, Package Specification, Package Body, Package Instantiation and Initialization.	
	<b>Transaction Management</b>	ACID Properties, Serializability, Two-phase Commit Protocol, Concurrency Control, Lock Management, Lost Update Problem, Inconsistent Read Problem, Read-Write Locks, Deadlocks Handling, Two Phase Locking protocol.	
	<b>Crash Recovery</b>	ARIES algorithm. The log-based recovery, recovery related structures like transaction and dirty page table, Write-ahead log protocol, check points, recovery from a system crash, Redo and Undo phases	

**Textbooks:**

1. Mastering PL/SQL through Illustrations: From Learning Fundamentals to Developing Efficient PL/SQL Blocks, Dr. B. Chandra, BPB Publication, 2020
2. Oracle Pl/Sql Training Guide., Training guide, BPB Publications, 2016
3. Raghu Ramakrishnam, Gehrke, Database Management Systems, McGraw- Hill, 3rd Edition, 2014
4. Abraham Silberschatz, Henry F. Korth, S.Sudarshan, Database System Concepts, 6th Edition 2019

**Additional References:**

1. Ivan Bayross, -SQL, PL/SQL -The Programming language of Oracle, B.P.B. Publications 2009
2. Ramez Elmasri & Shamkant B. Navathe, Fundamentals of Database Systems, Pearson Education, 2008

**Evaluation Pattern**

**A. Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular Object-oriented dynamic learning environment)</li> <li>The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behaviour</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)**

Duration: 2 hrs

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

**Advanced Database Concepts – Practical**

Name of the Course	<b>Advanced Database Concepts – Practical</b>
Course Code (refer to student handbook)	<b>USCSP304</b>
Class	SYBSc
Semester	III
No of Credits	1
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum: Lecture/ week: 3**

<b>The following practicals will be implemented using Oracle 11G Minimum 8 practicals to be completed as a journal work.</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
Practical -1	Writing PL/SQL Blocks with basic programming constructs by including following: <ol style="list-style-type: none"> <li>Sequential Statements</li> <li>unconstrained loop</li> </ol>
Practical -2	Sequences: <ol style="list-style-type: none"> <li>Creating simple Sequences with clauses like START WITH, INCREMENT BY, MAXVALUE, MINVALUE, CYCLE   NOCYCLE, CACHE   NOCACHE, ORDER   NOORDER.</li> </ol> Creating and using Sequences for tables.
Practical -3	Writing PL/SQL Blocks with basic programming constructs by including following: <ol style="list-style-type: none"> <li>If...then...Else, IF...ELSIF...ELSE... END IF</li> <li>Case statement</li> </ol>
Practical -4	Writing PL/SQL Blocks with basic programming constructs for following Iterative Structure: <ol style="list-style-type: none"> <li>While-loop Statements</li> <li>For-loop Statements.</li> </ol>
Practical -5	Writing PL/SQL Blocks with basic programming constructs by including a GoTO to jump out of a loop and NULL as a statement inside IF.
Practical -6	Writing Procedures in PL/SQL Block <ol style="list-style-type: none"> <li>Create an empty procedure, replace a procedure and call procedure</li> <li>Create a stored procedure and call it</li> <li>Define procedure to insert data</li> <li>A forward declaration of procedure</li> </ol>
Practical -7	Writing Functions in PL/SQL Block. <ol style="list-style-type: none"> <li>Define and call a function</li> <li>Define and use function in select clause,</li> <li>Call function in dbms_output.put_line</li> <li>Recursive function</li> <li>Count Employee from a function and return value back</li> </ol> Call function and store the return value to a variable
Practical -8	Creating and working with Insert/Update/Delete Trigger using Before/After clause.

Practical -9	Write an Implicit and explicit cursor to complete the task.
Practical -10	Create packages and use it in SQL block to complete the task.
Practical -11	Write a SQL block to handle exception by writing: a. Predefined Exceptions, b. User-Defined Exceptions, Re-declared Predefined Exceptions,
Practical -12	Create nested tables and work with nested tables.

**Learning Resources recommended:**

1. Mastering PL/SQL Through Illustrations: From Learning Fundamentals to Developing Efficient PL/SQL Blocks, Dr. B. Chandra, BPB Publication, 2020
2. Oracle Pl/Sql Training Guide., Training guide, BPB Publications, 2016
3. Raghu Ramakrishnam, Gehrke, Database Management Systems, McGraw-Hill,3rd Edition, 2014
4. Abraham Silberschatz, Henry F. Korth,S.Sudarshan , Database System Concepts, 6th Edition 2019

**Additional References:**

1. Ivan Bayross, -SQL, PL/SQL -The Programming language of Oracle, B.P.B. Publications 2009
2. RamezElmasri&Shamkant B. Navathe, Fundamentals of Database Systems, Pearson Education, 2008

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

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks****Duration: 1 hr**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Java based Application Development</b>
Course Code (refer to student handbook)	<b>USCS305</b>
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Nomenclature: Java based Application Development****Course Outcomes:**

- To provide insight into java based applications using OOP concepts.
- To provide understanding of developing GUI based desktop applications in java.
- To provide knowledge of web based applications through servlet and jsp.
- To provide understanding and implementation of basic JSON

**After successful completion of this course, students would be able to**

- Design basic applications in java using Graphical User Interface.
- The learner will be able to develop applications using swings
- The learner will be able to develop web based applications using servlet and jsp
- The learner will be able to connect databases with java through
- The learner will be able to perform programs using JSON objects

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
I	<b>Introduction</b>	History, Features of Java, Java Development Kit, Java Application Programming Interface, Java Virtual Machine Java Program Structure, Java Tokens.	15
	<b>OOPS</b>	Introduction, Class, Object, Static Keywords, Constructors, this keyword, Inheritance, Inner class, Anonymous Inner class, super keyword, Polymorphism (overloading and overriding), Abstraction, Encapsulation, Abstract Classes, Interfaces	
	<b>Packages</b>	Introduction to predefined packages, User Defined Packages, Access specifiers	
	<b>Exception Handling</b>	Introduction, Pre-Defined Exceptions, try-catch-finally, throws, throw, User Defined Exceptions	
	<b>Multithreading</b>	Thread Creations, Thread Life Cycle, Life Cycle Methods, Synchronization, wait() notify() notify all() methods	



<b>II</b>	<b>Collection Framework</b>	Introduction, java.util Package interfaces, List, Set, Map, List interface & its classes, Set interface & its classes, Map interface & its classes.	<b>15</b>
	<b>Introduction to JFC and Swing</b>	Features of the Java Foundation Classes, Swing API Components, JComponent Class, Windows, Dialog Boxes, and Panels, Labels, Buttons, Check Boxes, Menus, Toolbars, Implementing Action interface, Pane, JScrollPane, Desktop pane, Scrollbars, Lists and Combo Boxes, Text-Entry Components, Colors and File Choosers, Tables and Trees, Printing with 2D API and Java Print Service API.	
	<b>Event Handling</b>	Delegation Event Model, Events, Event classes, Event listener interfaces, Using delegation event model, adapter classes.	
	<b>JDBC</b>	Introduction, JDBC Architecture, JDBC Drivers, JDBC Connectivity Model, java.sql package, Using Statement, Prepared Statement, Callable Statement, ResultSet, Scrollable and Updatable ResultSet, Navigating and manipulating data, ResultSetMetaData, Managing Transactions in JDBC, JDBC Exception classes, BLOB & CLOB	
<b>III</b>	<b>Servlets</b>	Introduction, Servlet Life Cycle, Types of Servlet, Servlet Configuration with Deployment Descriptor, Working with ServletContext and ServletConfig Object, Attributes in Servlet, Response and Redirection using Request Dispatcher and using sendRedirect Method, Filter API, Manipulating Responses using Filter API, Session Tracking: using Cookies, HttpSession, Hidden Form Fields and URL Rewriting, Types of Servlet Event: Context Level and Session Level.	<b>15</b>
	<b>Java Server Pages (JSP)</b>	Introduction to JSP, Comparison with Servlet, JSP Architecture, JSP Life Cycle, JSP Scripting Elements, JSP Directives, JSP Action, JSP Implicit Objects, JSP Expression Language, JSP Standard Tag Libraries, JSP Custom Tag, JSP Session Management, JSP Exception Handling, JSP CRUD Applications	
	<b>JSON</b>	Overview, Syntax, Data Types, Objects, Schema, Comparison with XML, JSON with Java	

**Curriculum:****Learning Resources recommended:****Textbooks:**

1. Herbert Schildt, Java the Complete Reference, Eleventh Edition, McGraw-Hill Education, 2020
2. Bryan Basham, Kathy Sierra, Bert Bates, Head First Servlets and JSP, O'reilly (SPD), 2018
3. Cay S. Horstmann, Gary Cornell, Core Java™ 2: Volume II–Advanced Features Prentice Hall PTR, 2004
4. Ivan Bayross, Web Enabled Commercial Applications Development Using Java 2, BPB Publications
5. Java XML and JSON: Document Processing for Java SE by Jeff Friesen January 2019, Apress

**Additional References:**

1. E. Balagurusamy, Programming with Java- A Primer, Tata McGraw-Hill Education India, 2014
2. Programming in JAVA, 2nd Ed, Sachin Malhotra & Saurabh Choudhary, Oxford Press, 2018
3. Joe Wigglesworth and Paula McMillan, Java Programming: Advanced Topics, Thomson Course Technology (SPD)
4. Eric Jendrock, Jennifer Ball, D Carson and others, The Java EE 5 Tutorial, Pearson Education
5. The Java Tutorials: <http://docs.oracle.com/javase/tutorial/>
6. Java Parsing Collection XML JSON: Map List XML JSON Transform by Yang Hu, 2019

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>● It should be conducted using any <b>learning management system</b> such as <b>Moodle</b> (Modular object-oriented dynamic learning environment)</li> <li>● The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>● Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behaviour</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)**

Duration: 2 hrs

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

### Java based Application Development Practical

Name of the Course	Java based Application Development Practical
Course Code (refer to student handbook)	USCSP305
Class	SYBSc
Semester	III
No of Credits	1
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

#### Curriculum: Lecture/ week : 3

<b>The following practicals will be implemented using JAVA, NetBeans Minimum 8 practicals to be completed as a journal work.</b>	
Sr. No.	Practical Title
Practical -1	a. Write a program to create a class and implement the concepts of Constructor Overloading, Method Overloading, Static methods b. Write a program to implement the concept of Inheritance and Method Overriding
Practical -2	a. Write a program to implement the concepts of Abstract classes and methods b. Write a program to implement the concept of interfaces
Practical -3	Write a program to define user defined exceptions and raise them as per the requirements
Practical -4	Write a program to demonstrate the methods of: <ol style="list-style-type: none"> <li>a. List interface</li> <li>b. Set interface</li> <li>c. Map interface</li> </ol>
Practical -5	Write a program using various swing components design Java application to accept a student's resume. (Design form)
Practical -6	a. Write a JDBC program that displays the data of a given table b. Write a JDBC program to return the data of a specified record from a given table Write a JDBC program to insert / update / delete records into a given table
Practical -7	a. Construct a simple calculator using the JAVA Swings with minimum functionality. b. Construct a GUI using JAVA Swings to accept details of a record of a given table and submit it to the database using JDBC technology on the click of a button.

Practical -8	<ol style="list-style-type: none"> <li>Write a Servlet that accepts a User Name from a HTML form and stores it as a cookie. Write another Servlet that returns the value of this cookie and displays it.</li> <li>Write a Servlet that displays the names and values of the cookie stored on the client.</li> <li>Write a Servlet that accepts a User Name from a HTML form and stores it as a session variable. Write another Servlet that returns the value of this session variable and displays it.</li> </ol>
Practical -9	<ol style="list-style-type: none"> <li>Write a registration Servlet that accepts the data for a given table and stores it in the database.</li> <li>Write a Servlet that displays all the records of a table.</li> </ol>
Practical -10	<ol style="list-style-type: none"> <li>Write a JSP that accepts a User Name from a HTML form and stores it as a cookie. Write another JSP that returns the value of this cookie and displays it.</li> <li>Write a JSP that displays the names and values of the cookie stored on the client.</li> <li>Write a JSP that accepts a User Name from a HTML form and stores it as a session variable. Write another JSP that returns the value of this session variable and displays it.</li> </ol>
Practical -11	<ol style="list-style-type: none"> <li>Write a JSP code that accepts username and password from HTML file and validates the user from the database</li> <li>Write a registration JSP that accept the data for a given table and stores it in the database.</li> <li>Write a JSP that displays all the records of a table</li> </ol>
Practical -12	Write Java application to encoding and decoding JSON in Java.

### Learning Resources recommended:

#### Textbooks:

- Herbert Schildt, Java The Complete Reference, Eleventh Edition, McGraw-Hill Education, 2020
- Bryan Basham, Kathy Sierra, Bert Bates, Head First Servlets and JSP, O'reilly (SPD), 2018
- Cay S. Horstmann, Gary Cornell, Core Java™ 2: Volume II–Advanced Features Prentice Hall PTR, 2004
- Ivan Bayross, Web Enabled Commercial Applications Development Using Java 2, BPB Publications
- Java XML and JSON: Document Processing for Java SE by Jeff Friesen January 2019, Apress

#### Additional References:

- E. Balagurusamy, Programming with Java- A Primer, Tata McGraw-Hill Education India, 2014
- Programming in JAVA, 2nd Ed, Sachin Malhotra &SaurabhChoudhary, Oxford Press, 2018
- Joe Wigglesworth and Paula McMillan, Java Programming: Advanced Topics, Thomson Course Technology (SPD)
- Eric Jendrock, Jennifer Ball, D Carson and others, The Java EE 5 Tutorial, Pearson Education
- The Java Tutorials: <http://docs.oracle.com/javase/tutorial/>
- Java Parsing Collection XML JSON: Map List XML JSON Transform by Yang Hu, 2019

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

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks****Duration: 1 hr**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Web Technologies</b>
Course Code (refer to student handbook)	<b>USCS306</b>
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Nomenclature:** Web Technologies

**Course Outcomes:**

- To understand the concepts of Hyper Text Markup Language and Cascading Style Sheets.
- To learn JavaScript for creating dynamic websites.
- To learn various operations performed on data among web applications using XML
- To learn Server-Side Programming using PHP

**After successful completion of this course, students would be able to**

- Design valid, well-formed, scalable, and meaningful pages using emerging technologies.
- Understand the various platforms, devices, display resolutions, viewports, and browsers that render websites
- Develop and implement client-side and server-side scripting language programs.
- Develop and implement Database Driven Websites.
- Design and apply XML to create a markup language for data and document centric applications.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
I	<b>HTML5</b>	Fundamental Elements of HTML, Formatting Text in HTML, Organizing Text in HTML, Links and URLs in HTML, Tables in HTML, Images on a Web Page, Image Formats, Image Maps, Colors, FORMs in HTML, Interactive Elements, Working with Multimedia - Audio and Video File Formats, HTML elements for inserting Audio / Video on a web page	15
	<b>CSS</b>	Understanding the Syntax of CSS, CSS Selectors, Inserting CSS in an HTML Document, CSS properties to work with background of a Page, CSS properties to work with Fonts and Text Styles, CSS properties for positioning an element.	

<b>II</b>	<b>JavaScript</b>	Using JavaScript in an HTML Document, Programming Fundamentals of JavaScript – Variables, Operators, Control Flow Statements, Popup Boxes, Functions – Defining and Invoking a Function, Defining Function arguments, defining a return Statement, Calling Functions with Timer, JavaScript Objects - String, RegExp, Math, Date, Browser Objects - Window, Navigator, History, Location, Document, Cookies, Document Object Model, Form Validation using JavaScript	<b>15</b>
	<b>XML</b>	Comparing XML with HTML, Advantages and Disadvantages of XML, Structure of an XML Document, XML Entity References, DTD, XSLT: XSLT Elements and Attributes - xsl:template, xsl:apply-templates, xsl:import, xsl:call-template, xsl:include, xsl:element, xsl:attribute, xsl:attribute-set, xsl:value-of	
<b>III</b>	<b>AJAX</b>	AJAX Web Application Model, How AJAX Works, XMLHttpRequest Object – Properties and Methods, handling asynchronous requests using AJAX	<b>15</b>
	<b>PHP</b>	Variables and Operators, Program Flow, Arrays, working with Files and Directories, working with Databases, Working with Cookies, Sessions and Headers	
	<b>Introduction to jQuery</b>	Fundamentals, Selectors, methods to access HTML attributes, methods for traversing, manipulators, events, effects.	

**Learning Resources recommended:****Textbooks:**

1. HTML 5 Black Book, Covers CSS 3, JavaScript, XML, XHTML, AJAX, PHP and jQuery, 2ed, Dreamtech Press, 2016
2. Web Programming and Interactive Technologies, scriptDemics, StarEdu Solutions India, 2018
3. PHP: A Beginners Guide, VikramVaswani, TMH

**Additional References:**

1. HTML, XHTML, and CSS Bible Fifth Edition, Steven M. Schafer, WILEY, 2011
2. Learning PHP, MySQL, JavaScript, CSS & HTML5, Robin Nixon, O'Reilly, 2018
3. PHP, MySQL, JavaScript & HTML5 All-in-one for Dummies, Steve Suehring, Janet Valade Wiley, 2018

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular Object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05

<b>Behavior</b>	05
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**B. Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

<b>Question No</b>	<b>Unit</b>	<b>Options</b>	<b>Marks</b>
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15



**Web Technologies - Practical**

Name of the Course	<b>Web Technologies – Practical</b>
Course Code (refer to student handbook)	<b>USCSP306</b>
Class	SYBSc
Semester	III
No of Credits	1
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum: Lecture/ week : 3**

<b>The following practicals will be implemented using Notepad, XAMPP Server, Browser Application</b>	
<b>Minimum 8 practicals to be completed as a journal work.</b>	
<b>Sr.No.</b>	<b>Practical Title</b>
Practical -1	Design a webpage that makes use of <ol style="list-style-type: none"> <li>a. Document Structure Tags</li> <li>b. Various Text Formatting Tags</li> <li>c. List Tags</li> <li>d. Image and Image Maps</li> </ol>
Practical -2	Design a webpage that makes use of <ol style="list-style-type: none"> <li>a. Table tags</li> <li>b. Form Tags (forms with various form elements)</li> <li>c. Navigation across multiple pages</li> <li>d. Embedded Multimedia elements</li> </ol>
Practical -3	Design a webpage that make use of Cascading Style Sheets with <ol style="list-style-type: none"> <li>a. CSS properties to change the background of a Page</li> <li>b. CSS properties to change Fonts and Text Styles</li> <li>c. CSS properties for positioning an element</li> </ol>
Practical -4	Write JavaScript code for <ol style="list-style-type: none"> <li>a. Performing various mathematical operations such as calculating factorial / finding Fibonacci Series / Displaying Prime Numbers in a given range / Evaluating Expressions / Calculating reverse of a number</li> <li>b. Validating the various Form Elements</li> </ol>
Practical -5	Write JavaScript code for <ol style="list-style-type: none"> <li>a. Demonstrating different JavaScript Objects such as String, RegExp, Math, Date</li> <li>b. Demonstrating different JavaScript Objects such as Window, Navigator, History, Location, Document,</li> <li>c. Storing and Retrieving Cookies</li> </ol>
Practical -6	Create a XML file with Internal / External DTD and display it using <ol style="list-style-type: none"> <li>a. CSS</li> <li>b. XSL</li> </ol>

Practical -7	Design a webpage to handle asynchronous requests using AJAX on a. Mouseover b. button click
Practical -8	Write PHP scripts for a. Retrieving data from HTML forms b. Performing certain mathematical operations such as calculating factorial / finding Fibonacci Series / Displaying Prime Numbers in a given range / Evaluating Expressions / Calculating reverse of a number c. Working with Arrays d. Working with Files (Reading / Writing)
Practical -9	Write PHP scripts for a. Working with Databases (Storing Records / Retrieving Records and Display them) b. Storing and Retrieving Cookies c. Storing and Retrieving Sessions
Practical -10	Design a webpage with some jQuery animation effects.

### Evaluation Pattern

#### A. Internal Examination: 20 Marks

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical which are timely completed with desired output	10
2	Attendance & Practical Performance	10

#### B. Semester End Examination: 30 Marks

Duration: 1 hr

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Creative Content Writing</b>
Course Code (refer to student handbook)	<b>USCS3071</b>
Class	S.Y.B.Sc
Semester	III
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Nomenclature: Creative Content Writing****Course Outcomes:**

- To introduce students to the concepts of content writing.
- To connect them with various writing and editing styles and techniques.
- To help them develop their creative abilities.
- To improve the learners' employability

**After successful completion of this course, students would be able to**

- Understand the fundamentals of content creation for Blog, Website etc.
- Acquire the ability to write and edit in a variety of styles and procedures
- To develop creative abilities.
- To acquire essential language skills for editors.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Basics of Content writing</b>	Introduction to Content Writing, Learning Tone in Writing and Its Types, Comprehending style in writing and its Types, Common Grammatical Errors.	<b>15</b>
	<b>Best Practices for Writing for the Web</b>	Making our story Elegant, Professional, Write with an Attitude, Keep Verbs Active, List Items, Chunk Information, Title and Subtitle, Organize for Your Audience.	
	<b>Things Marketers Write</b>	The Ideal Length for Blog Posts, Podcast, Facebook Posts, Tweets, and Other Marketing Content.	
<b>II</b>	<b>Social Media Writing</b>	Writing for Twitter, writing with Hashtags, Writing Social Media with Humor, writing for Facebook, writing for LinkedIn, Writing Your LinkedIn Profile, writing for Email, Writing Landing Pages, Writing Headlines, writing a Home Page, Writing the About Us Page, Writing Better Blog Posts, Writing Annual Reports.	<b>15</b>

	<b>Infographics:</b>	Visual Communication-What Are Infographics?, The Science of Visualization, Creating Infographics-Purpose, The Art of Observation, Processing Your Ideas, Designing Your Infographics, Publishing Your Infographics.	
<b>III</b>	<b>Content Tools.</b>	Research and Knowledge Management Tools, Writing Tools, Productivity Tools, Editing Tools, A Few Great Style Guides, Non-Text Writing Tools, Blog Idea Generators, Google Authorship, Image Sources, Tools for Content Writing.	<b>15</b>
	<b>Ethical and Legal aspects of content writing</b>	Learn Legal English, Learn Legal Vocabulary In Legal Writing, IPR Laws, and Copywriting, Plagiarism laws in Content Writing.	

**Learning Resources recommended:****Textbooks:**

- 1.Content Writing Handbook, Author:Kounal Gupta, 2020, Henry Harvin.
- 2.Feldar, Lynda. Writing for the Web: Creating Compelling Web Content Using Words, Pictures, and Sound. New Riders, CA, USA, 2011

**Additional References:**

1. Everybody Writes: Your Go-To Guide to Creating Ridiculously Good Content Paperback Ann Handley Pan Macmillan India 2016
2. The Power of Infographics: Using Pictures to Communicate and Connect With Your Audiences Paperback – 15 June 2012 Mark Smiciklas
3. Law Relating to Intellectual Property Rights Book by V. K. Ahuja, 2017

**Web Resources:**

1. <https://www.locationrebel.com/b2b-writing/>
2. <https://www.mindler.com/blog/how-to-become-a-content-writer-in-india/>
3. [https://study.com/articles/What is a Content Writer.html](https://study.com/articles/What_is_a_Content_Writer.html)
4. <https://www.mondaq.com/india/contracts-and-commercial-law/445620/legal-contractsareements-drafting-and-legal-vetting>
5. <https://www.crazyegg.com/blog/copywriting/>

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

<b>Method</b>	<b>Marks</b>
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>● It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modularobject-orienteddynamiclearning environment)</li> <li>● The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>● Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)**

**Duration: 2 hrs**

<b>Question No</b>	<b>Unit</b>	<b>Options</b>	<b>Marks</b>
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Green Technologies</b>
Course Code (refer to student handbook)	<b>USCS3072</b>
Class	S.Y.B.Sc.
Semester	III
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Nomenclature: Green Technologies****Course Outcomes:**

- Know about Green IT Fundamentals: Business, IT, and the Environment
- Green IT Strategies and Significance of Green IT Strategies
- Green Enterprise Architecture and Green Information Systems
- Sociocultural Aspects of Green IT and Green Compliance

**After successful completion of this course, students would be able to**

- Explain drivers and dimensions of change for Green Technology
- Appreciate Virtualization; smart meters and optimization in achieving green IT
- Gain knowledge about green assets, green processes, and green enterprise architecture
- ISO 14001 and related standards for Audit for Green Compliance

<b>Curriculum :</b>			
<b>Unit</b>	<b>Title</b>	<b>Learning Points</b>	<b>No of Lectures</b>
<b>I</b>	<b>Green IT Fundamentals</b>	Information Technology and Environment, Business, Environment, and Green Enterprise Characteristics, Green Vision and Strategic Points, Green Value, Green IT Opportunity, Challenges of a Carbon Economy, Environmental Intelligence, Envisioning the Green Future	<b>15</b>
	<b>Green IT Strategies</b>	Green strategic alignment, Green IT Drivers-Cost, Regulatory and Legal, Sociocultural and Political, Business ecosystem, New market opportunities, Green IT Business Dimensions, KPIs in Green Strategies	
	<b>Environmentally Responsible Business</b>	Developing ERBS, Policies, Practices, and Metrics, Mobility and Environment, Green It Metrics and Measurements, Green IT Readiness and CMM, Context Sensitivity and Automation in Green IT Measures	
	<b>Green Assets</b>	Introduction, Green Assets, Green IT Hardware, Green Data Centers and ICT Equipment, Server and Data Strategy	
<b>II</b>	<b>Green Assets and emerging Trends</b>	Data Servers Optimization and Virtualization, Physical Data Server Organization and Cooling, Cloud Computing and Data Centers, Networking and Communications Infrastructure, End-User Devices, Smart Meters in Real-Time, Managing Devices for Central Green Services, Devices and Organizational Boundaries for Measurements, Mobile Devices, and Sustainability	<b>15</b>
	<b>Green Business Process Management</b>	Introduction, Green Reengineering, Green Process, Green BPM and standards, Green Business Analysis, Green Requirements Modelling, Green IT Governance, Green Business Process and Applications, QoS, Achieving green BPM, Green Mobile Business Process, Digital Library	
	<b>Green Enterprise Architecture</b>	Green IT and organizational Systems, Aspects of Green Solutions Architecture, Contents and Integration with Service-Oriented Architecture, Green Supply Chain Management, Green Portals in Green Enterprise Architecture, Environmental Intelligence	
<b>III</b>	<b>Green Information Systems(GIS)</b>	Describing GIS, GIS Requirements	<b>15</b>
	<b>Sociocultural Aspects of Green IT</b>	Green IT's Social Impact, Learning Organization, Green Social Stakeholders, Role-Based View of Green IT, Green User Practices, Attitude and Subjectivity in Green IT, Green IT Ethics and Code of Conduct, Privacy and Security of Green Information, Green Washing, Communications in Green Transformation Projects, Green HR and Changing Organizational Structures, Green-Collar Workers: Roles and Skill Sets, Green Virtual Communities	

<b>Green Compliance: Protocols, Standards, and Audits</b>	Protocols and Standards, ISO 14000-2004 Standard, Various initiatives by stakeholders, Green Audits and types, Audit and use of Carbon emission management software
<b>Emerging Carbon Issues</b>	Technologies and Future: Future Carbon Landscape, Green ICT and Technology Trends, Cloud Computing, Nanotechnology, Quantum computing, Renewable energies, eco-design, Collaborative environmental intelligence

**Learning Resources recommended:****Textbooks:**

1. Green IT Strategies and Applications Using Environmental Intelligence, BhuvanUnhelkar, CRC Press, 2016
2. Green Information and Communication Systems for a Sustainable Future, Rajshree Srivastava, Sandeep Kautish, Rajeev Tiwari. CRC Press, 2020

**Additional References:**

3. Emerging Green Technologies, Matthew N. O. Sadiku, Taylor and Francis (CRC Press), 2022
4. Sustainability Awareness and Green Information Technologies, TomayessIssa, Springer, 2021
5. Environmental Sustainability Role of Green Technologies, P. Thangavel, and G. Sridevi, Springer, 2016

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular Object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	All Units	Any 3 out of 5	15



**Revised Syllabus of Courses of B.Sc. Computer Science Programme at Semester IV****Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Theory of Computation</b>
Course Code (refer to student handbook)	<b>USCS401</b>
Class	S. Y. B. Sc.
Semester	IV
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Nomenclature: Theory of Computation****Course Outcomes:**

- To give an overview of the theoretical foundations of computer science from the perspective of formal languages
- To illustrate finite state machines to solve problems in computing
- To explain the hierarchy of problems arising in the computer sciences.
- To familiarize Regular grammars, context free grammar.

**After successful completion of this course, students would be able to :**

- Understand Grammar and Languages
- Learn about Automata theory and its application in Language Design
- Learn about Turing Machines and Pushdown Automata
- Understand Linear Bound Automata and its applications

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Automata Theory:</b>	Defining Automaton, Finite Automaton, Transitions and Its properties, Acceptability by Finite Automaton, Nondeterministic Finite State Machines, DFA and NFA equivalence, Mealy and Moore Machines, Minimizing Automata.	<b>15</b>
	<b>Formal Languages:</b>	Defining Grammar, Derivations, Languages generated by Grammar, Chomsky Classification of Grammar and Languages, Recursive Enumerable Sets, Operations on Languages, Languages and Automata	
<b>II</b>	<b>Regular Grammar:</b>	Grammar, Regular Expressions, Finite automata and Regular Expressions, Pumping Lemma and its Applications, Closure Properties, Regular Sets and Regular Grammar	<b>15</b>
	<b>Context Free Languages:</b>	Context-free Languages, Derivation Tree, Ambiguity of Grammar, CFG simplification, Normal Forms, Pumping Lemma for CFG	

	<b>Pushdown Automata</b>	Definitions, Acceptance by PDA, PDA and CFG	
<b>III</b>	<b>Linear Bound Automata</b>	The Linear Bound Automata Model, Linear Bound Automata and Languages.	<b>15</b>
	<b>Turing Machines:</b>	Turing Machine Definition, Representations, Acceptability by Turing Machines, Designing and Description of Turing Machines, Turing Machine Construction, Variants of Turing Machine	
	<b>Undecidability:</b>	The Church-Turing thesis, Universal Turing Machine, Halting Problem, Introduction to Unsolvability Problems	

**Learning Resources recommended:****Textbooks:**

1. Theory of Computer Science, K. L. P Mishra, Chandrasekharan, PHI, 3rd Edition 2019
2. Introduction to Computer Theory, Daniel Cohen, Wiley, 2nd Edition, 2007
3. Introductory Theory of Computer Science, E.V. Krishnamurthy, Affiliated East-West Press, 2009

**Additional References:**

1. Theory of Computation, Kavi Mahesh, Wiley India, 2018
2. Elements of The Theory of Computation, Lewis, Papadimitriou, PHI, 2015
3. Introduction to Languages and the Theory of Computation, John E Martin, McGraw-Hill Education, 2010
4. Introduction to Theory of Computation, Michel Sipser, Thomson
5. Introduction to Automata Theory, Languages and Computation, John E. Hopcroft, Pearson Education, 2014

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular Object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Theory of Computation – Practical</b>
Course Code (refer to student handbook)	<b>USCSP401</b>
Class	SYBSc
Semester	IV
No of Credits	1
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Curriculum:****Lecture/ week : 3**

<b>The following practicals will be implemented using Python Minimum 8 practicals to be completed as a journal work.</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
Practical -1	Write a program for tokenization of given input
Practical -2	Write a program for generating regular expressions for regular grammar
Practical -3	Write a program for generating derivation sequence / language for the given sequence of productions
Practical -4	Design a Program for creating machine that accepts three consecutive one.
Practical -5	Design a Program for creating machine that accepts the string always ending with 101.
Practical -6	Design a program for accepting decimal number divisible by 2.
Practical -7	Design a program for creating a machine which accepts string having equal no. of 1's and 0's.
Practical -8	Design a program for creating a machine which count number of 1's and 0's in a given string.
Practical -9	Design a PDA to accept WCWR where w is any string and WR is reverse of that string and C is a Special symbol.
Practical -10	Design a Turing machine that's accepts the following language $anbncn$ where $n > 0$

**Learning Resources recommended:**

1. Theory of Computer Science, K. L. P Mishra, Chandrasekharan, PHI, 3rd Edition 2019
2. Introduction to Computer Theory, Daniel Cohen, Wiley, 2nd Edition, 2007
3. Introductory Theory of Computer Science, E.V. Krishnamurthy, Affiliated East-West Press, 2009

**Additional References:**

1. Theory of Computation, Kavi Mahesh, Wiley India, 2018
2. Elements of The Theory of Computation, Lewis, Papadimitriou, PHI, 2015
3. Introduction to Languages and the Theory of Computation, John E Martin, McGraw-Hill Education, 2010
4. Introduction to Theory of Computation, Michel Sipser, Thomson
5. Introduction to Automata Theory, Languages and Computation, John E. Hopcroft, Pearson Education, 2014

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

Sr No	Criterion	Marks
1	Journals containing minimum 8 practicals which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks****Duration: 1 hr**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Computer Networks</b>
Course Code (refer to student handbook)	<b>USCS402</b>
Class	S.Y.B.Sc.
Semester	IV
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Nomenclature: Computer Networks****Course Outcomes:**

- To Understand Basic Concepts of Networking.
- To Understand Working of Network Layer Architecture.
- To Learn Practical Implementation of Basic Routing Algorithms.
- To Learn Different Networking Protocols.

**After successful completion of this course, students would be able to**

- Learn basic networking concepts and layered architecture.
- Understand the concepts of networking, which are important for them to be known as networking professionals.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
I	<b>Introduction:</b>	Networking standards and Administrations, networks, network types – LAN, MAN, WAN.	15
	<b>Network Models:</b>	The OSI model, TCP/IP protocol suite,	
	<b>Introduction to Physical layer:</b>	Data and signals, periodic analog signals, digital signals, transmission impairment, data rate limits, performance.	
	<b>Digital transmissions:</b>	Digital-to-digital conversion, analog-to-digital conversion, transmission modes	
	<b>Analog transmissions:</b>	digital-to-analog conversion, analog-to-analog conversion.	
	<b>Bandwidth Utilization</b>	Multiplexing, Spread Spectrum	
	<b>Transmission media:</b>	Guided Media, Unguided Media	
	<b>Switching:</b>	Introduction, Circuit Switched Network, Packet Switching.	
II	<b>Introduction to Data Link Layer:</b>	Link layer addressing, Data Link Layer Design Issues.	15
	<b>Error detection and correction</b>	Block coding, cyclic codes, checksum, forward error correction, error correcting codes, error detecting codes.	
	<b>Data Link Control: DLC</b>	DLC services, data link layer protocols, HDLC, Point-to-point protocol.	

	<b>Media Access Control:</b>	Random access, controlled access, channelization,	<b>15</b>
	<b>Wired LANs – Ethernet:</b>	Ethernet Protocol, standard Ethernet, fast Ethernet, gigabit Ethernet, 10 gigabit Ethernet	
	<b>Wired Network:</b>	Telephone Network, Cable Network, SONET, ATM	
	<b>Wireless LANs:</b>	Introduction, IEEE 802.11 project, Bluetooth, WiMAX, Cellular telephony, Satellite networks.	
	<b>Introduction to Network Layer:</b>	Network layer services, packet switching, network layer performance, IPv4 addressing, forwarding of IP packets,	
	<b>Network Layer Protocols :</b>	Internet Protocol, ICMPv4, Mobile IP	
<b>III</b>	<b>Unicast Routing:</b>	Introduction, routing algorithms, unicast routing protocols.	<b>15</b>
	<b>Next generation IP</b>	IPv6 addressing, IPv6 protocol, ICMPv6 protocol, transition from IPv4 to IPv6.	
	<b>Introduction to the Transport Layer:</b>	Transport Layer Protocol, User Datagram Protocol, Transmission Control Protocol, SCTP.	
	<b>Introduction to Application Layer:</b>	Client Server Programming, Iterative Programming.	
	<b>Standard Client-Server Protocols:</b>	WWW, HTTP, FTP, Electronic Mail, TELNET, Secure Shell, DNS, SNMP	
	<b>Quality of Service:</b>	Data Flow to improve QoS, Flow control to improve QoS, Integrated service (Intserv), Differentiated Service(Diffserv).	

**Learning Resources recommended:****Textbooks:**

1. Data Communications and Networking, Behrouz A. Forouzan, Fifth Edition, TMH, 2018.
2. Computer Network, Andrew S. Tanenbaum, David J. Wetherall, Fifth Edition, Pearson Education, 2018.

**Additional References:**

1. Computer Network, Bhushan Trivedi, Oxford University Press, 2016
2. Data and Computer Communication, William Stallings, PHI, 2017

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

<b>Method</b>	<b>Marks</b>
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>● It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modularobject-orienteddynamiclearning environment)</li> <li>● The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	<b>20</b>
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>● Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	<b>10</b>
<b>Attendance</b>	<b>05</b>
<b>Behavior</b>	<b>05</b>

**B. Semester End Evaluation: 60 marks (Paper Pattern)**

**Duration: 2 hrs**

<b>Question No</b>	<b>Unit</b>	<b>Options</b>	<b>Marks</b>
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Computer Networks – Practical</b>
Course Code (refer to student handbook)	<b>USCSP402</b>
Class	SYBSc
Semester	IV
No of Credits	1
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Curriculum: Lecture/ week : 3**

<b>The following practicals will be implemented using Cisco Packet Tracer Minimum 8 practicals to be completed as a journal work.</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
Practical -1	Using, linux-terminal or Windows-cmd, execute following networking commands and note the output: ping, traceroute, netstat, arp, ipconfig, Getmac, hostname, NSLookUp, pathping, SystemInfo
Practical -2	Using Packet Tracer, create a basic network of two computers using appropriate network wire. Use Static IP address allocation and show connectivity
Practical -3	Using Packet Tracer, create a basic network of One server and two computers using appropriate network wire. Use Dynamic IP address allocation and show connectivity
Practical -4	Using Packet Tracer, create a basic network of One server and two computers and two mobile / movable devices using appropriate network wire. Show connectivity
Practical -5	Using Packet Tracer, create a network with three routers with RIPv1 and each router associated network will have minimum three PC. Show Connectivity
Practical -6	Using Packet Tracer, create a network with three routers with RIPv2 and each router associated network will have minimum three PC. Show Connectivity
Practical -7	Using Packet Tracer, create a network with three routers with OSPF and each router associated network will have minimum three PC. Show Connectivity
Practical -8	Using Packet Tracer, create a network with three routers with BGP and each router associated network will have minimum three PC. Show Connectivity
Practical -9	Using Packet Tracer, create a wireless network of multiple PCs using appropriate access point.
Practical -10	Using Wireshark, network analyzer, set the filter for ICMP, TCP, HTTP, UDP, FTP and perform respective protocol transactions to show/prove that the network analyzer is working

**Learning Resources recommended:**

1. Data Communications and Networking, Behrouz A. Forouzan, Fifth Edition, TMH, 2018.
2. Computer Network, Andrew S. Tanenbaum, David J. Wetherall, Fifth Edition, Pearson Education, 2018.

**Additional References:**

1. Computer Network, Bhushan Trivedi, Oxford University Press, 2016



2. Data and Computer Communication, William Stallings, PHI, 2017

### Evaluation Pattern

#### A. Internal Examination: 20 Marks

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical which are timely completed with desired output	10
2	Attendance & Practical Performance	10

#### B. Semester End Examination: 30 Marks

Duration: 1 hr

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Software Engineering</b>
Course Code (refer to student handbook)	<b>USCS403</b>
Class	S.Y.B.Sc.
Semester	IV
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Nomenclature: Software Engineering****Course Outcomes:**

- To learn and understand the Concepts of Software Engineering
- To learn and understand Software Development Life Cycle
- To apply the project management and analysis principles to software project development.
- To apply the design & testing principles to software project development.

**After successful completion of this course, students would be able to**

- Plan a software engineering process life cycle, including the specification, design, implementation, and testing of software systems that meet specification, performance, maintenance and quality requirements
- Analyze and translate a specification into a design, and then realize that design practically, using an appropriate software engineering methodology.
- Know how to develop the code from the design and effectively apply relevant standards and perform testing, and quality management and practice
- Able to use modern engineering tools necessary for software project management, time management and software reuse.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
I	<b>Introduction:</b>	The Nature of Software, Software Engineering, Professional Software Development, Layered Technology, Process framework, CMM, Process Patterns and Assessment Prescriptive Models: Waterfall Model, Incremental, RAD Models Evolutionary Process Models: Prototyping, Spiral and Concurrent Development Model Specialized Models: Component based, Aspect Oriented development, The Unified Process Phases, Agile Development- Agility, Agile Process, Extreme Programming	15
	<b>Requirement Analysis and System Modeling:</b>	Requirements Engineering, Eliciting Requirements, SRS Validation, Components of SRS, Characteristics of SRS, Object-oriented design using the UML - Class diagram, Object diagram, Use case diagram, Sequence diagram, Collaboration diagram, State chart diagram, Activity diagram, Component diagram, Deployment diagram	

<b>II</b>	<b>System Design:</b>	System/Software Design, Architectural Design, Low-Level Design Coupling and Cohesion, Functional-Oriented Versus Object-Oriented Approach, Design Specifications, Verification for Design, Monitoring and Control for Design	<b>15</b>
	<b>Software Measurement and Metrics:</b>	Process Metrics and Project Metrics, Software Measurement, Object Oriented Metrics, Software Project Estimation, Decomposition Techniques, LOC based, FP based and Use case based estimations, Empirical estimation Models	
	<b>Software Project Management:</b>	<b>Estimation</b> in Project Planning Process, –Software Scope and Feasibility, Resource Estimation, Empirical Estimation Models – COCOMO II, Estimation for Agile Development, The Make/Buy Decision	
	<b>Project Scheduling:</b>	Basic Principles, Relationship Between People and Effort, Effort Distribution, Time-Line Charts	
<b>III</b>	<b>Risk Management:</b>	Risk strategies, Software risks, Risk Identification, projection, RMMM Quality Concepts	<b>15</b>
	<b>Software Quality Assurance:</b>	SQA activities, Software reviews, FTR, Software reliability and measures, SQA plan Software Configuration Management, elements of SCM, SCM Process, Change Control Capability Maturity Model	
	<b>Software Testing:</b>	Verification and Validation, Introduction to Testing, Testing Principles, Testing Objectives, Test Oracles, Levels of Testing, White-Box Testing/Structural Testing, Functional/Black-Box Testing, Test Plan, Test-CaseDesign	

**Learning Resources recommended:****Textbooks:**

1. Software Engineering, A Practitioner’s Approach, Roger S, Pressman, 2019
2. Software Engineering: principles and Practices, Deepak Jain, OXFORD University Press, 2008

**Additional References:**

1. Software Engineering, Ian Sommerville, Pearson Education, 2017
2. Fundamentals of Software Engineering, Fourth Edition, Rajib Mall, PHI, 2018
3. Software Engineering: Principles and Practices, Hans Van Vliet, John Wiley & Sons, 2010
4. A Concise Introduction to Software Engineering, PankajJalote, SpringerIntroduction to Automata Theory, Languages and Computation, John E. Hopcroft, Pearson Education, 2014

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

<b>Method</b>	<b>Marks</b>
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modularobject-orienteddynamiclearning environment)</li> <li>• The test should have <b>20 MCQ’s</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)**

**Duration: 2 hrs**

<b>Question No</b>	<b>Unit</b>	<b>Options</b>	<b>Marks</b>
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Software Engineering – Practical</b>
Course Code (refer to student handbook)	<b>USCSP403</b>
Class	SYBSc
Semester	IV
No of Credits	1
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Nomenclature:** Software Engineering – Practical

**Course Outcomes:**

- To learn and understand the Concepts of Software Engineering
- To learn and understand Software Development Life Cycle
- To apply the project management and analysis principles to software project development.
- To apply the design & testing principles to software project development.

**After successful completion of this course, students would be able to**

- Plan a software engineering process life cycle, including the specification, design, implementation, and testing of software systems that meet specification, performance, maintenance and quality requirements
- Analyze and translate a specification into a design, and then realize that design practically, using an appropriate software engineering methodology.
- Know how to develop the code from the design and effectively apply relevant standards and perform testing, and quality management and practice
- Able to use modern engineering tools necessary for software project management, time management and software reuse.

**Curriculum: Lecture/ week : 3**

<b>Minimum 8 practicals to be completed as a journal work.</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
Practical -1	Write down the problem statement for a suggested system of relevance
Practical -2	Perform requirement analysis and develop Software Requirement Specification Sheet(SRS) for suggested system.
Practical -3	Draw the function oriented diagram: Data Flow Diagram (DFD) and Structured chart.
Practical -4	Draw the user_s view analysis for the suggested system: Use case diagram.
Practical -5	Draw the structural view diagram for the system: Class diagram, object diagram.
Practical -6	Draw the behavioral view diagram : State-chart diagram, Activity diagram
Practical -7	Draw the behavioral view diagram for the suggested system: Sequence diagram, Collaboration diagram
Practical -8	Draw the implementation and environmental view diagram: Component diagram, Deployment diagram
Practical -9	Perform Estimation of effort using FP Estimation
Practical -10	Prepare timeline chart/Gantt Chart/PERT Chart
Practical -11	Develop test cases for unit testing and integration testing
Practical -12	Develop test cases for various white box and black box testing

**Learning Resources recommended:**

1. Software Engineering, A Practitioner's Approach, Roger S, Pressman, 2019
2. Software Engineering: principles and Practices, Deepak Jain, OXFORD University Press, 2008

**Additional References:**

1. Software Engineering, Ian Sommerville, Pearson Education, 2017
2. Fundamentals of Software Engineering, Fourth Edition, Rajib Mall, PHI, 2018
3. Software Engineering: Principles and Practices, Hans Van Vliet, John Wiley & Sons, 2010
4. A Concise Introduction to Software Engineering, Pankaj Jalote, Springer

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

Sr No	Criterion	Marks
1	Journals containing minimum 8 practicals which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks****Duration: 1 hr**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>IoT Technologies</b>
Course Code (refer to student handbook)	<b>USCS404</b>
Class	S.Y.B.Sc.
Semester	IV
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Nomenclature: IoT Technologies****Course Outcomes:**

- Introduce concepts of SoC and IoT
- Introduce various types of IoT platforms
- Interfacing various types of devices using different protocols with IoT
- Understand practical applications of IoT in real life world

**After successful completion of this course, students would be able to**

- understand SoC and IoT
- use different types of IoT Platforms and interfaces
- understand and implement an idea of various types of applications built using IoT

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Fundamentals of IoT:</b>	Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M.	<b>15</b>
	<b>System on Chip:</b>	What is System on chip? Structure of System on Chip. SoCElements: FPGA, GPU, APU, Compute Units.	
	<b>Different types of IoT/SoC Platforms:</b>	Introduction to Raspberry Pi, Arduino&NodeMCU, Introduction to SoC-ARM Architecture, atmega328 architecture	
<b>II</b>	<b>Interfacing with IoT Platforms</b>	Basic hardware components like LED, Button, Camera, 8X8 LED Grid, Motor etc and interfacing them for input/output with IoT devices using PWM, UART, GPIO, I2C, SPI	<b>15</b>

	<b>Using Sensor &amp; Actuators:</b>	Overview of Sensors working, Analog and Digital Sensors, Interfacing of Temperature, Humidity, Motion, Light and Gas Sensor, Level Sensors, Ultrasonic sensors, Interfacing of Actuators, Interfacing of Relay Switch and Servo Motor	
	<b>IoT and Protocols IoT Security:</b>	HTTP, UPnP, CoAP, MQTT, XMPP, Privacy and Security Issues in IoT.	
<b>III</b>	<b>IoT &amp; Web:</b>	Web server for IoT, Sending/Receiving data between web server & IoT device, Cloud for IoT, Node RED, M2M vs IoT Communication Protocols, Basics of WSNs, WSN architecture and types,	<b>15</b>
	<b>IoT Applications:</b>	Modern IoT case studies / applications used in the areas of transportation, agriculture, health care etc	
	<b>Edge Computing:</b>	Edge computing purpose and definition, Edge computing use cases, Edge computing hardware architectures, Edge platforms, Edge vs Fog Computing, Communication Models - Edge, Fog and M2M.	

**Learning Resources recommended:****Textbooks:**

1. Introduction to IoT Paperback by Sudip Misra, Anandarup Mukherjee, Arijit Roy, Cambridge Press, 2022
2. Jain, Prof. Satish, Singh, Shashi, -Internet of Things and its Applications, 1st Edition, BPB, 2020.
3. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, Internet of Things, Wiley, India, 2019
4. IoT and Edge Computing for Architects - Second Edition, by Perry Lea, Publisher: Packt Publishing, 2020

**Additional References:**

1. Internet of Things by Vinayak Shinde, SYBGEN Learning India Pvt. Ltd, 2020
2. Internet of things, Dr. Kamlesh Lakhwani, Dr. Hemant Kumar Gianey, Josef Kofi Wireko, Kamalkant Hiran, BPB Publication, 2020
3. Arduino, Raspberry Pi, NodeMCU Simple projects in easy way by Anbazhagan K and Ambika Parameswari K, 2019.
4. IoT based Projects: Realization with Raspberry Pi, NodeMCU Paperback – February 2020, by Rajesh Singh Anita Gehlot, 2020
5. Mastering the Raspberry Pi, Warren Gay, Apress, 2014

**Evaluation Pattern****A .Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10



<b>Attendance</b>	05
<b>Behavior</b>	05

**B .Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

<b>Question No</b>	<b>Unit</b>	<b>Options</b>	<b>Marks</b>
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	IoT Technologies – Practical
Course Code (refer to student handbook)	USCSP404
Class	SYBSc
Semester	IV
No of Credits	1
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Nomenclature:** IoT Technologies – Practical

- Introduce concepts of SoC and IoT
- Introduce various types of IoT platforms
- Interfacing various types of devices using different protocols with IoT
- Understand practical applications of IoT in real life world

**After successful completion of this course, students would be able to**

- understand SoC and IoT
- use different types of IoT Platforms and interfaces
- understand and implement an idea of various types of applications built using IoT

**Curriculum:****Lecture/ week : 3**

<b>The following practicals will be implemented using Raspberry Pi Minimum 8 practicals to be completed as a journal work.</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
Practical -1	Preparing Raspberry Pi: Hardware preparation and Installation
Practical -2	Demonstrate Arduino Uno and its pins interfacing with IDE.
Practical -3	GPIO: Light the LED with Python with/without a button using either Uno/Raspberry Pi.
Practical -4	SPI: Camera Connection and capturing Images/Videos using SPI
Practical -5	GPIO: LED Grid Module: Program the 8X8 Grid with Different Formulas
Practical -6	Stepper Motor Control: PWM to manage stepper motor speed using Uno/Raspberry Pi.
Practical -7	Node RED: Connect LED to Internet of Things
Practical -8	Use different types of sensors (LDR, Temperature) with Raspberry Pi/Uno.
Practical -9	Trigger a set of led GPIO on any IoT platform via any related web server
Practical -10	Interface with any sensor and send its value over the internet to the server using any suitable protocol

**Learning Resources recommended:**

1. Introduction to IoT Paperback by SudipMisra , Anandarup Mukherjee , Arijit Roy , Cambridge Press, 2022
2. Jain, Prof. Satish, Singh, Shashi, -Internet of Things and its Applications, 1st Edition, BPB, 2020.

3. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, Internet of Things, Wiley, India, 2019
4. IoT and Edge Computing for Architects - Second Edition, by Perry Lea, Publisher: PacktPublishing, 2020

**Additional References:**

1. Internet of Things by VinayakShinde, SYBGEN Learning India Pvt. Ltd, 2020
2. Internet of things, Dr. KamleshLakhwani, Dr. HemantkumarGianey, Josef Kofi Wireko, KamalkantHiran, BPB Publication, 2020
3. Arduino, Raspberry Pi, NodeMCU Simple projects in easy way by Anbazhagan k and AmbikaParameswari k, 2019.
4. IoT based Projects: Realization with Raspberry Pi, NodeMCU Paperback – February 2020, by Rajesh Singh Anita Gehlot, 2020
5. Mastering the Raspberry Pi, Warren Gay, Apress, 2014

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

Sr No	Criterion	Marks
1	Journals containing minimum 8 practicals which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks****Duration: 1 hr**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Android Application Development</b>
Course Code (refer to student handbook)	<b>USCS405</b>
Class	S.Y.B.Sc.
Semester	IV
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Nomenclature: Android Application Development****Course Outcomes:**

- Kotlin Programming Language for application development
- Creating robust mobile applications on simulators and physical devices
- Creating intuitive, reliable mobile apps using the android services and components
- Handling data local and remote data storage
- Create a seamless user interface that works with different mobile screens

**After successful completion of this course, students would be able to**

- Build useful mobile applications using Kotlin language on Android
- Install and configure Android Studio for application development
- Master basic to intermediate concepts of Kotlin required for mobile application development
- Use built-in widgets and components, work with the database to store data
- Master key Android programming concepts and deploy the application on Google Play

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
I	<b>Introduction to Kotlin:</b>	Basics of Kotlin, type conversions, comments, Kotlin operators, variables in Kotlin, packages, visibility modifiers, control flow statements, Concept of OOPS in Kotlin, classes in Kotlin, delegation and extension functions, the companion object,	15
	<b>Advanced Concepts in Kotlin:</b>	declaring and calling functions, parameters, and arguments in Kotlin, default argument, variable number of arguments, unit-returning function, explicit return type, lambda expression, coroutines, Collections in Kotlin, Mutable and Immutable Collections, Ranges, type Checks, casting concept, this expression, Null safety, exception handling, annotations	
	<b>App Development with Android Studio:</b>	Android Architecture, Android Application Framework, Android Virtual Device, Creating and running First Android Application, working with Physical Android Device, Adding Kotlin Files in Android Studio	
	<b>Basics Of Android:</b>	Application Components: Activities, Intent, and Broadcast Receiver, Services, Fragment, Activity Life Cycle, Content Provider, Widgets, and Notifications	

<b>II</b>	<b>Designing Android UI:</b>	User Interface (UI), Layout and Its Types, Layout Attribute, working with Views, Android UI Controls, Styles and Themes, Event Handler, setting up themes in Manifest and from the application, dialog in activity, using intents, fragments	<b>15</b>
	<b>Handle Images, ListviewAnd Menu:</b>	ImageView, ImageSwitcher, ListView, Menu, and its types, Designing menu in XML, Option menu, Context menu, popup menu, <b>Screen</b> Navigation, RecyclerView, Interaction of Views	
	<b>Data binding in Android:</b>	AdapterView, Spinner, Gallery view, AutotextCompleteView, screen orientation, Designtheviewdynamically	
	<b>Implementing Data Persistence:</b>	Data Storage-Shared Preference, Internal And External Storage Storing Data Using SQLite Databases, Content Provider, Firebase Real-Time Data	
<b>III</b>	<b>Graphics, Animations, and Integrating Media in Android: ,</b>	Drawable Class, Animation in Android, MediaPlayer API and in Android, Mediaplayer and AudioManger Class,	<b>15</b>
	<b>Interacting With Camera</b>	and input gestures: Android Camera, Input gestures-multiple touch, swipe, drag, scroll, zoom, Recording	
	<b>Managing Background Tasks:</b>	Broadcaset Receivers, Services, Threads and Process, AsyncTask, JobScheduler, Manage device Awake State	
	<b>Deploying Android applications on Google Play</b>	Publishing/Deploy the application, Versioning, signing Application	

**Learning Resources recommended:****Textbooks:**

1. How to Build Android Apps with Kotlin: A hands-on guide to developing, testing, and publishing your first apps with Android, Alex Forrester, Packt Publishing, 2021
2. Android Programming: Crafting UI/UX using Kotlin, SYBGEN Learning, 2020

**Additional References:**

1. Head First Android Development: A Learner's Guide to Building Android Apps with Kotlin Dawn Griffiths, 3rd Edition, O'Reilly Media, 2021
2. Android Studio 4.2 Development Essentials - Kotlin Edition: Developing Android Apps Using Android Studio 4.2, Kotlin and Android Jetpack, Neil Smyth, Payload Media, 2021
3. Android Programming with Kotlin for Beginners, John Horton, Packt Publishing, 2019
4. Android Development with Kotlin: Enhance your skills for Android development using Kotlin, MarcinMoskala, PacktPublishingIntroduction to Automata Theory, Languages and Computation, John E. Hopcroft, Pearson Education, 2014

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

<b>Method</b>	<b>Marks</b>
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>● It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modula robject -orienteddynamiclearning environment)</li> <li>● The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	<b>20</b>

<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

<b>Question No</b>	<b>Unit</b>	<b>Options</b>	<b>Marks</b>
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	Android Application Development – Practical
Course Code (refer to student handbook)	USCSP405
Class	SYBSc
Semester	IV
No of Credits	1
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Nomenclature:** Android Application Development – Practical

**Course Outcomes:**

- Kotlin Programming Language for application development
- Creating robust mobile applications on simulators and physical devices
- Creating intuitive, reliable mobile apps using the android services and components
- Handling data local and remote data storage
- Create a seamless user interface that works with different mobile screens

**After successful completion of this course, students would be able to**

- Build useful mobile applications using Kotlin language on Android
- Install and configure Android Studio for application development
- Master basic to intermediate concepts of Kotlin required for mobile application development
- Use built-in widgets and components, work with the database to store data
- Master key Android programming concepts and deploy the application on Google Play

**Curriculum: Lecture/ week: 3**

<b>The following practicals will be implemented using Android Studio Minimum 8 practicals to be completed as a journal work.</b>	
Sr. No.	Practical Title
Practical -1	i. Write a program using Kotlin to implement control structures and loops. ii. Write a program to implement object-oriented concepts in Kotlin.
Practical -2	i. Create an Android application to design screens using different layouts and UI including Button, Edittext, Textview, Radio Button etc. ii. Write an android application demonstrating response to event/user interaction for <ol style="list-style-type: none"> <li>a. Checkbox</li> <li>b. Radio button</li> <li>c. Button</li> <li>d. Spinner</li> </ol>
Practical -3	i. Create an application to create Image Flipper and Image Gallery. On click on the image display the information about the image. ii. Create an application to use Gridview for shopping cart application.
Practical -4	i. Create an Android application to demonstrate implicit and explicit intents ii. Create an application to demonstrate shared preferences

Practical -5	<ul style="list-style-type: none"> <li>i. Create an Android application to demonstrate the use of Broadcast listeners.</li> <li>ii. Create an Android application to create and use services.</li> </ul>
Practical -6	<ul style="list-style-type: none"> <li>i. Create an Android application to demonstrate XML based animation</li> <li>ii. Create an Android application to display canvas and allow the user to draw on it.</li> </ul>
Practical -7	<ul style="list-style-type: none"> <li>i. Create a media player application in android that plays audio. Implement play, pause, and loop features.</li> <li>ii. Create an Android application to use a camera and capture image/video and display them on the screen.</li> </ul>
Practical -8	<ul style="list-style-type: none"> <li>i. Create an android application to implement AsyncTask and threading concepts.</li> <li>ii. Create an Android application to demonstrate the different types of menus. <ul style="list-style-type: none"> <li>a. Pop-up Menu</li> <li>b. Context Menu</li> <li>c. Option Menu</li> </ul> </li> </ul>
Practical -9	Create an Android application to record the current location. Based on the current location allow the user to use some useful services/applications
Practical -10	Create a suitable Android application to store and retrieve data in the SQLite database.
Practical -11	Create a suitable Android application to work with Firebase for storing and manipulating data.

**Learning Resources recommended:**

1. How to Build Android Apps with Kotlin: A hands-on guide to developing, testing, and publishing your first apps with Android, Alex Forrester, Packt Publishing, 2021
2. Android Programming: Crafting UI/UX using Kotlin, SYBGEN Learning, 2020

**Additional References:**

1. Head First Android Development: A Learner's Guide to Building Android Apps with Kotlin Dawn Griffiths, 3rd Edition, O'Reilly Media, 2021
2. Android Studio 4.2 Development Essentials - Kotlin Edition: Developing Android Apps Using Android Studio 4.2, Kotlin and Android Jetpack, Neil Smyth, Payload Media, 2021
3. Android Programming with Kotlin for Beginners, John Horton, Packt Publishing, 2019
4. Android Development with Kotlin: Enhance your skills for Android development using Kotlin, MarcinMoskala, Packt Publishing

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

Sr No	Criterion	Marks
1	Journals containing minimum 8 practicals which are timely completed with desired output	10
2	Attendance & Practical Performance	10



**B. Examination: 30 Marks**

**Duration: 1 hr**

<b>Sr No</b>	<b>Criterion</b>	<b>Marks</b>
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Advanced Application Development</b>
Course Code (refer to student handbook)	<b>USCS406</b>
Class	S.Y.B.Sc.
Semester	IV
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Nomenclature: Advanced Application Development****Course Outcomes:**

- To understand all the necessary and important technologies such as MongoDB, Express.js, AngularJS, and Node.js.
- To understand modern app development using Flutter

**After successful completion of this course, students would be able to**

- Store the data in NoSQL, a document-oriented MongoDB database that brings performance and scalability.
- Use Node.js and Express Framework for building fast, scalable network applications
- Use AngularJS framework that offers declarative, two-way data binding for web applications.
- Integrate the front-end and back-end components of the MEAN stack.
- Develop robust mobile applications using Flutter.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
I	<b>Node.js (N):</b>	Introduction to Node.js. Installing Node.js. The package.json File. The Node.js Event Loop. The I/O Cycle. The Anatomy of a Node.js Module. Creating Node Modules. Exploring the Node.js HTTP Module. Creating an HTTP Webserver with Node.js. Responding to HTTP Requests. Routing in Node.js. Creating a Sample Node.js Application.	15
	<b>MongoDB(M):</b>	Introduction to MongoDB. Installing MongoDB. Using MongoDB Compass. Using Mongo Shell Interface. Connecting to MongoDB. Creating Schemas and Models. Querying Documents Using find(). Inserting Documents Using create(). Updating Documents Using findOneAndUpdate(). Deleting Documents Using findOneAndDelete() & deleteMany()	
II	<b>Server-Side Development with Express (E)</b>	Introduction to the Express Framework. Installing and Testing Express. Creating a Node.js Express App. Restructuring an Express App. Creating Templates. Using Express Middleware Functions. Creating the List Page. Creating the Details Page. Creating the Edit Page. Creating the Add Page. Deleting Data. REST API Basics. Testing REST APIs. Refactoring APIs.	15

	<b>Understanding Angular.JS(A):</b>	UGetting Started with Angular. Creating an Angular Application. Angular Project File Structure. Anatomy of an Angular Component. One-way Data Binding. Two-way Data Binding. Using NgIf Directive. Using NgForOf Directive. Angular Modules. Creating NgModulesUsing Angular Router. Configuring Templates. Creating Navigations. Working with Template-driven Forms. Working with Reactive Forms. Validating Form Data. Services Dependency Injection (DI). Reading Data from Database. Inserting Data into Database. Updating Data in the Database. Delete Data from Database.	
<b>III</b>	<b>Understanding Flutter:</b>	Importance of Flutter, Flutter Framework, Android Studio, Flutter SDK, Installing and Configuring Flutter SDK.	<b>15</b>
	<b>Dart Programming:</b>	main() function, Dart Variables, Dart Data Types, Dart Conditional Operators, Control Flow & Loops. Dart Functions - Functions, Function Structure, creating a Function, Function Returning Expression. Object-Oriented Programming (OOP) - Creating a Class, Adding Methods to Classes, Class — Getters and Setters, Class Inheritance, Abstract Class.	
	<b>Flutter Widgets Fundamentals:</b>	Scaffold Widget, Image Widget, Container Widget, Column and Row Widgets, Icon Widget, Layouts in Flutter, Card Widget, Hot Reload and Hot Restart, Stateful and Stateless Widgets	
	<b>Navigation and Routing:</b>	Button Widget, App Structure and Navigation, Navigate to a New Screen and Back, Navigate with Named Routes, Send and Return Data among Screens, Animate a Widget across Screens, WebView Widget in Flutter	

**Learning Resources recommended:****Textbooks:**

1. Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications by Brad Dayley, Brendan Dayley, Caleb Dayley, Pearson, 2018.
2. Beginning Flutter: A Hands On Guide to App Development by Marco L. Napoli, Wrox, 2019

**Additional References:**

1. Full Stack Javascript Development with Mean - MongoDB, Express, AngularJS, and Node.JS by Adam Bretz, Colin J Ihrig, Shroff/SitePoint, 2015
2. Practical Flutter by Zammetti Frank, Apress, 2019

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behaviour</b>	05

**Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Advanced Application Development – Practical</b>
Course Code (refer to student handbook)	<b>USCSP406</b>
Class	SYBSc
Semester	IV
No of Credits	1
Nature	Practical
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	The course aims at developing scalable, robust, and maintainable web applications using MEAN stack and developing advanced mobile applications using Flutter

**Nomenclature: Advanced Application Development – Practical****Course Outcomes:**

- To understand all the necessary and important technologies such as MongoDB, Express.js, AngularJS, and Node.js.
- To understand modern app development using Flutter

**After successful completion of this course, students would be able to**

- Store the data in NoSQL, document-oriented MongoDB database that brings performance and scalability.
- Use Node.js and Express Framework for building fast, scalable network applications
- Use AngularJS framework that offers declarative, two-way data binding for web applications.
- Integrate the front-end and back-end components of the MEAN stack.
- Develop robust mobile applications using Flutter.

**Curriculum: Lecture/ week: 3**

**The following practicals will be implemented using JAVA, MongoDB, VSCode, Acroid Studio, Node.js**  
**Minimum 8 practicals to be completed as a journal work.**

Sr. No.	Practical Title
Practical -1	Write a program to implement MongoDB data models
Practical -2	Write a program to implement CRUD operations on MongoDB
Practical -3	Write a program to perform validation of a form using AngularJS
Practical -4	Write a program to create and implement modules and controllers in Angular JS
Practical -5	Write a program to implement Error Handling in Angular JS
Practical -6	Create an application for Customer / Students records using AngularJS
Practical -7	Write a program to create a simple web application using Express, Node JS and Angular JS
Practical -8	Create a simple HTML -Hello World   Project using AngularJS Framework and apply ng-controller, ng-model and expressions
Practical -9	Create an app using Flutter for User Authentication
Practical -10	Create an app using Flutter to implement an Image Gallery
Practical -11	Create an app using Flutter to demonstrate the use of different layouts
Practical -12	Create an app using Flutter to demonstrate navigation in an App

**Learning Resources recommended:**

1. Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications by Brad Dayley, Brendan Dayley, Caleb Dayley, Pearson, 2018.
2. Beginning Flutter: A Hands On Guide to App Development by Marco L. Napoli, Wrox, 2019

**Additional References:**

1. Full Stack Javascript Development with Mean - MongoDB, Express, AngularJS, and Node.JS by Adam Bretz, Colin J Ihrig, Shroff/SitePoint, 2015
2. Practical Flutter by Zammetti Frank, Apress, 2019

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

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks****Duration: 1 hr**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for SYBSc Computer Science – Implementation  
Year 2023-24**

Name of the Course	<b>Research Methodology</b>
Course Code (refer to student handbook)	<b>USCS4071</b>
Class	S.Y.B.Sc.
Semester	IV
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Nomenclature: Research Methodology****Course Outcomes:**

- The research methodology course is proposed to assist students in planning and carrying out research projects.
- The students are exposed to the principles, procedures and techniques of implementing research project.
- The course starts with an introduction to research and carries through the various methodologies involved.
- It continues with finding out the literature using technology, basic statistics required for research and finally report writing.

**After successful completion of this course, students would be able to**

- Define research, formulate problem and describe the research process and research methods.
- Understand and apply basic research methods including research design, data analysis and interpretation.
- Understand ethical issues in research write research report, research paper and publish the paper.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Introduction to Research Methodology:</b>	Meaning of Research, Objectives of Research, Motivations in Research, types of Research, Research Approaches, Significance of Research, Research Methods v/s Methodology, Research and Scientific Methods, Research Process, Criteria of Good Research.	<b>15</b>
	<b>Defining the Research Problem:</b>	Concept and need, Identification of Research problem, defining and delimiting Research problem.	
	<b>Formulating a Research Problem:</b>	Reviewing Literature, formulating a Research Problem, Research Question, Identifying Variables, Constructing Hypothesis	
	<b>The Research Design:</b>	<b>The Research Design:</b> Meaning, Need for Research Design, Important Concepts, Different Research Designs, Basic Principles of Experimental Designs.	

<b>II</b>	<b>Tools for Data Collection:</b>	Collections of Primary Data, Collection of Data through questionnaire and Schedules, other Observation Interview Methods, Collection of Secondary Data, Selection of appropriate method for data collection, Case Study, Focus Group Discussion, Techniques of developing research tools, viz. Questionnaire and rating scales etc. Reliability and validity of Research tools.	<b>15</b>
	<b>Sampling Design</b>	Steps in Sampling Design, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, Different Types of Sample Designs, how to Select a Random Sample. Probability and Non-Probability sampling types and criteria for selection, Developing sampling Frames.	
	<b>Overview of Hypothesis Testing:</b>	What is a Hypothesis? Characteristics of good Hypothesis. Basic Concepts, Procedure for Hypothesis Testing, Flow Diagram for Hypothesis Testing, Tests of Hypotheses, and One sided and two-sided hypothesis, Type – I and Type – II errors, Null Hypothesis- Alternative Hypothesis.	
<b>III</b>	<b>Technical Writing:</b>	Writing a Research Proposal, what is a Scientific Paper? Ethics in Scientific Publishing.	<b>15</b>
	<b>Preparing the Text:</b>	How to Prepare the Title, how to List the Authors and Addresses, how to Prepare the Abstract, how to Write the Introduction, how to Write the Materials and Methods Section, how to Write the Results, how to Write the Discussion, how to State the Acknowledgments, how to Cite the References.	
	<b>Preparing the Tables and Figures:</b>	How to Design Effective Tables, how to Prepare Effective Graphs, how to Prepare Effective Photographs.	
	<b>Publishing the Paper:</b>	Rights and Permissions, How to Submit the Manuscript, How and When to Use Abbreviations, How to Write a thesis, Outcome of Research, Ethical issues in research	

**Learning Resources recommended:****Textbooks:**

1. Kothari C.R., Research Methodology, New Age International Publication, 2019
2. Research Methodology-A Step-by-Step Guide for Beginners, (4th ed.), Ranjit Kumar, Singapore, Pearson Education, 2018
3. Research Methodology, VaishaliKhairnar, Staredu Solutions India Pvt Ltd, 2020

**Additional References:**

1. Research Methodology: Methods and Techniques, Dr. R. K. Jain, , Fifth Edition, VEI, 2021
2. Research Methodology, R. Panneerselvam, Second Edition, PHI, 2014
3. Dr. Rachna Jain, Research Methodology, Maximax Publishing House
4. How to Write and Publish a Scientific Paper, Cambridge University Press, Barbara Gastel and Robert A. Day, 2017



**Evaluation Pattern****A. Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modularobject-orienteddynamiclearning environment)</li> <li>The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b> .	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

**Syllabus for SYBSc Computer Science – Implementation Year 2023-24**

Name of the Course	<b>Management &amp; Entrepreneurship</b>
Course Code (refer to student handbook)	<b>USCS4072</b>
Class	S.Y.B.Sc
Semester	IV
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Nomenclature: Management & Entrepreneurship****Course Outcomes:**

- To understand the idea of management, process and its levels.
- To understand the perception of entrepreneurship, process and its types.
- To understand the concept of SSI and steps to start SSI.
- To understand the selection of project, project report, project appraisal, and its feasibility.

**After successful completion of this course, students would be able to**

- Understand the meaning of management, functions, administration and its process.
- Understand the foundation of entrepreneurship and its theory, types and its process.
- Identify the steps involved in an entrepreneurial venture (SSI).
- Understanding an entrepreneur is converting his business ideas into running concerns by selecting the project.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
I	<b>Introduction: Meaning,</b>	Meaning, Characteristics of Management, Nature of Management, Management Functions, Functional Areas of Management, Management and Administration, Role of Management, Levels of Management, Evolution of Management	15
	<b>Planning:.</b>	Importance, types of planning, types of plans, planning process, decision-making.	
	<b>Organizing and staffing:</b>	Meaning and Definitions of Organizing, Steps in Organizing, Nature of Organization, Organization Structure, Purpose of Organization, Principles of Organization, Departmentation, Types of Organization, Span of Control, Authority, Power and Responsibility, Delegation of Authority, Centralization and Decentralization, Delegation vs Decentralization, Management by Objectives [MBO], Meaning of Staffing, Nature and Importance of Staffing, Recruitment, Selection.	

<b>II</b>	<b>Directing and Controlling:</b>	Meaning and Nature of Direction, Principles of Directing, Leadership and Leadership Styles, Motivation, Communication, Noise and Feedback in Communication, Importance of Communication, Channels of Communication, Types of Communication, Forms of Communication, Coordination, Coordination and Cooperation, Importance of Coordination, Techniques of Coordination, Managerial Control, Steps in a Control Process, Essentials of a Sound Control System, Control Methods.	<b>15</b>
	<b>Entrepreneurship:</b>	Evolution of Concept of Entrepreneur, Concept of Entrepreneur, Characteristics of Entrepreneur, Distinction between Entrepreneur and Manager, Technical Entrepreneur, Charms of Being an Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneurs, Intrapreneurs, Ultrapreneurs, Concept of Entrepreneurship, Evolution of Entrepreneurship, Role of Entrepreneurship in Economic Development, Stages in the Entrepreneurial Process, Barriers to Entrepreneurship	
<b>III</b>	<b>Small Scale Industry:</b>	Meaning and Definition of Small-Scale Industry, Characteristics of SSI, Objectives, Scope, Role of SSI in Economic Development, Advantages of Small-Scale Industries, steps to Start an SSI, Government Policy towards SSI	<b>15</b>
	<b>Preparation of Project:</b>	Meaning, Project Classification, Project Identification, Project Report and its significance, Contents of a Project Report, Formulation of Project Report, Planning Commission Guidelines, Network Analysis, Common Mistakes by Entrepreneurs in Project Formulation, Project Appraisal, Identification of Opportunity, Project Feasibility study.	

**Learning Resources recommended:****Textbooks:**

1. HavinalVeerabhadrapa, Management and Entrepreneurship, New Age International Publishers.
2. KanishkaBedi, Management and Entrepreneurship, Oxford University Press
3. Dr. R. K. Singal, Entrepreneurship Development and Management

**Additional References:**

1. P. N. Singh, J. C. Saboo, Entrepreneurship Management, 6th Edition, Dr. P. N. Singh Centre for Hrd Publications.
2. Donald L. Sexton & Raymond W. Smilor, The Art and Science of Entrepreneurship, Ballinger, 2022
3. Clifford M. Baumbach & Joseph R. Mancuso, Entrepreneurship And Venture Management, Prentice Hall

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular Object-oriented dynamic learning environment)</li> <li>The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)**

Duration: 2 hrs

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

The Chairperson,  
BoS of Computer Science

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**Affiliated to  
University of Mumbai**



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

**Bachelor of Science (B.Sc.)  
Programme-Computer Science  
Three Year Integrated Programme  
Six Semesters**

***Course Structure***

**T. Y. BSc. Sem V & VI**

**Choice Based Credit System (CBCS)**

**Implementation Year – 2023-24**

### Preamble

This is a third year curriculum in the subject of Computer Science. The revised and restructured curriculum for the three year integrated course is systematically designed considering the National Education Policy (NEP) along with the Autonomy constraints. The syllabus aims to provide students with a comprehensive understanding of computer science concepts, theories, and practical skills, enabling them to excel in the dynamic and rapidly evolving field of technology. The revised and restructured curriculum for the Three-year integrated course is systematically designed considering the current industry needs in terms of skill sets demanded in the new technological environment. It also endeavors to align the program structure and course curriculum with student aspirations and corporate expectations.

The curriculum contains two semesters, each semester contains two Electives: Elective-I and II. Every elective contains three papers based on specific areas of computer science. It also include one skill enhancement paper per semester, helps the student to evaluate his/ her computer science domain specific skill and also to meet industry expectations. The curriculum is contextual, industry-friendly, and suitable to cater to the needs of society and the nation in the present-day environment. The T.Y.BSc Computer Science syllabus is structured as follows: Core Modules: The syllabus comprises core modules that cover essential topics in computer science, ensuring a strong foundation that aim to develop computational thinking, analytical abilities, and problem solving skills among students. The Artificial Intelligence course provides in-depth knowledge of cutting edge AI concepts and techniques empowering them to develop intelligent systems and algorithms. With a focus on safeguarding information and systems the Cyber and Information Security course equips students with essential concepts and practices in cybersecurity. The Data Science course provides students with a solid foundation in data analysis and interpretation, enabling them to extract valuable insights and make data-driven decisions. In an era dominated by cloud-based technologies, the Cloud Computing course focuses on the principles, architectures, and applications of cloud computing. Skill Enhancement Electives: Students are required to choose skill enhancement electives to deepen their knowledge in specific areas of interest. The electives offer specialized courses such as web development, cybersecurity, data science, or software engineering.

By selecting these courses, students can tailor their learning experience according to their career aspirations and industry demands. Skill Enhancement courses such as Linux Server Administration, Software Testing and Quality Assurance, Cyber Forensics, Game Programming, Data Mining and Warehousing, Wireless and Sensor Networks, Ethical Hacking, and Information Retrieval cater to specialized areas of expertise and industry demands. Generic Electives: The syllabus also includes generic electives, which provide students with the option to explore disciplines of interest beyond their choices in Core and Discipline-Specific Elective papers. These courses broaden their horizons and allow for interdisciplinary learning.

Project Work: A significant component of the syllabus involves hands-on project work. Through practical assignments and projects, students have the opportunity to apply their theoretical knowledge to real-world scenarios. This approach fosters creativity, problem-solving skills, and innovation in designing and developing software solutions. Assessment methods for the TY Computer Science syllabus include written examinations, practical assignments, project evaluations, and presentations. This comprehensive approach ensures that students' understanding is evaluated through various mediums, emphasizing both theoretical knowledge and practical skills.

The newly designed TY Computer Science syllabus aims to equip students with the necessary competencies to pursue careers in software development, data analysis, research, or further studies in computer science related disciplines. It seeks to empower students with the knowledge and skills required to thrive in the ever-evolving landscape of technology and contribute to the advancement of the field. We sincerely believe that students who undertake this program will gain a strong foundation and exposure to the basics, advanced concepts, and emerging trends in the subject. We express our gratitude to all the experts who provided valuable feedback and suggestions to improve the curriculum. We have made sincere efforts to incorporate their inputs. In essence, the objective of

this syllabus is to create a pool of technologically savvy, theoretically strong, innovatively skilled and ethically responsible generation of computer science professionals.

Special thanks to the Department of Computer Science, Gogate Jogalekar College(Autonomous), Ratnagiri and all honorable members of the Board of Studies of Computer Science, who volunteered or have directly or indirectly, helped design certain specialized courses and the syllabus as a whole.

Name of Programme	<b>B Sc Computer Science</b>
Level	UG
No of Semesters	06
Year of Implementation	<b>2023</b>
Programme Specific Outcomes (PSO)	<ol style="list-style-type: none"> <li>1. To formulate, model, design solutions, procedure and to use software tools to solve real world problems.</li> <li>2. To design and develop computer programs/computer -based systems in the areas such as networking, web design, security, cloud computing, IoT, data science and other emerging technologies.</li> <li>3. To familiarize with the modern-day trends in industry and research based settings and thereby innovate novel solutions to existing problems.</li> <li>4. To apply concepts, principles, and theories relating to computer science to new situations.</li> <li>5. To use current techniques, skills, and tools necessary for computing practice</li> <li>6. To apply standard Software Engineering practices and strategies in real-time software project development</li> <li>7. To pursue higher studies of specialization and to take up technical employment.</li> <li>8. To work independently or collaboratively as an effective team member on a substantial software project.</li> <li>9. To communicate and present their work effectively and coherently.</li> <li>10. To display an ethical code of conduct in usage of Internet and Cyber systems.</li> <li>11. To engage in independent and life-long learning in the background of rapid changing IT industry</li> </ol>
Relevance of PSOs to the local, regional, national, and global developmental needs (200 words)	<p>The revised and restructured curriculum for the Three-year integrated course is systematically designed considering the National Education Policy(NEP) along with the Autonomy constraints.The focus is on current industry needs in terms of skills sets demanded under the new technological environment. It also endeavors to align the programme structure and course curriculum with student aspirations and corporate expectations. The curriculum is more contextual, industry friendly and suitable to cater the needs of society and nation in the present day context.</p> <p>As the world is heading towards digitalization, the syllabus is framed by concentrating on such needs. With the help of basic programming skills and designing technique, a student is able to make small workable projects which can be beneficial for local vendors. To make these projects strong, various concepts of project management, database management are involved.</p> <p>Various industries need IT support at local or across the country. Students having the skills of computers are able to sustain in the IT industry at various locations.</p> <p>Development in thought processes can lead one in a research area to contribute to an upcoming trend. Students can become entrepreneurs since the techniques of management and entrepreneurship are taught</p>



	<p>to them.</p> <p>Due to the learning of cyber safety, ethical hacking, students can become ethical hackers where students can contribute to national security. Students can make community awareness due to learning about cyber safety.</p> <p>Continuous growth in trends requires students updated which will help them mercurial. This will help in sustaining the IT industry and become employable.</p>
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**T.Y.B.Sc. Computer Science Syllabus**  
**Choice Based Credit System (CBCS)**  
**Implementation Year- 2023-24**

<b>SEMESTER V</b>			
<b>Course</b>	<b>TOPICS</b>	<b>Credits</b>	<b>L / Week</b>
	<b>Elective-I (Select Any Two)</b>		
USCS501	Artificial Intelligence	3	3
USCS502	Linux Server Administration	3	3
USCS503	Software Testing and Quality Assurance	3	3
	<b>Elective-II (Select Any Two)</b>		
USCS504	Information and Network Security	3	3
USCS505	Architecting of IoT	3	3
USCS506	Web Services	3	3
	<b>Skill Enhancement</b>		
USCS507	Game Programming	2	3
	<b>Practical</b>		
USCSP501	Practical of Elective-I	2	6
USCSP502	Practical of Elective-II	2	6
USCSP503	Project Implementation	1	3
USCSP504	Practical of Skill Enhancement : USCS507	1	3

**T.Y.B.Sc. Computer Science Syllabus**  
**Choice Based Credit System (CBCS)**  
**Implementation Year- 2023-24**

<b>SEMESTER VI</b>			
<b>Course</b>	<b>TOPICS</b>	<b>Credits</b>	<b>L / Week</b>
	<b>Elective-I (Select Any Two)</b>		
USCS601	Wireless Sensor Networks and Mobile Communication	3	3
USCS602	Cloud Computing	3	3
USCS603	Cyber Forensics	3	3
	<b>Elective-II (Select Any Two)</b>		
USCS604	Information Retrieval	3	3
USCS605	Digital Image Processing	3	3
USCS606	Data Science	3	3
	<b>Skill Enhancement</b>		
USCS607	Ethical Hacking	2	3
	<b>Practical</b>		
USCSP601	Practical of Elective-I	2	6
USCSP602	Practical of Elective-II	2	6
USCSP603	Project Implementation	1	3
USCSP604	Practical of Skill Enhancement : USCS607	1	3

*Revised Syllabus of Courses of B.Sc. Computer Science Programme at Semester V  
Implementation Year 2023-2024*

**Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24**

Name of the Course	<b>Artificial Intelligence</b>
Course Code (refer to student handbook)	<b>USCS501</b>
Class	TYBSc
Semester	V
No of Credits	3
Nature	Theory
Type (applicable to NEP only)	---
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---

**Nomenclature: Artificial Intelligence**

**Course Outcomes:**

- To get a clear understanding of AI and different search algorithms used for solving problems.
- To get acquainted with different learning algorithms and models used in machine learning.
- To study Machines capability.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>What Is AI</b>	Foundations, History and State of the Art of AI.	<b>15</b>
	<b>Intelligent Agents</b>	Agents and Environments, Nature of Environments, Structure of Agents.	
	<b>Problem Solving by searching</b>	Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions.	
<b>II</b>	<b>Learning from Examples</b>	Forms of Learning, Supervised Learning, Learning Decision Trees, Evaluating and Choosing the Best Hypothesis, Theory of Learning, Regression and Classification with Linear Models, Artificial Neural Networks, Nonparametric Models, Support Vector Machines, Ensemble Learning, Practical Machine Learning	<b>15</b>
<b>III</b>	<b>Learning probabilistic models</b>	Statistical Learning, Learning with Complete Data, Learning with Hidden Variables: The EM Algorithm. Reinforcement learning: Passive Reinforcement Learning, Active Reinforcement Learning, Generalization in Reinforcement Learning, Policy Search, Applications of Reinforcement Learning.	<b>15</b>

**Learning Resources recommended:**

**Textbook(s):**

- 1) Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 3rd Edition, Pearson, 2010.

**Additional Reference(s):**

- 1) Artificial Intelligence: Foundations of Computational Agents, David L Poole, Alan K. Mackworth, 2nd Edition, Cambridge University Press, 2017.
- 2) Artificial Intelligence, Kevin Knight and Elaine Rich, 3rd Edition, 2017
- 3) The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani and Jerome Friedman, Springer, 2013

**Evaluation Pattern**

**A . Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B .Semester End Evaluation: 60 marks (Paper Pattern) Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Artificial Intelligence</b>
Course Code (refer to student handbook)	<b>USCSP501</b>
Class	TYBSc
Semester	V
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:**

Lecture/ week : 3

<b>Practical shall be implemented using Python Minimum 8 practical to be implemented as a journal work</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
1.	Implement Breadth first search algorithm for Romanian map problem.
2.	Implement Iterative deep depth first search for Romanian map problem.
3.	Implement A* search algorithm for Romanian map problem.
4.	Implement recursive best-first search algorithm for Romanian map problem.
5.	Implement decision tree learning algorithm for the restaurant waiting problem.
6.	Implement feed forward back propagation neural network learning algorithm for the restaurant waiting problem.
7.	Implement Adaboost ensemble learning algorithm for the restaurant waiting problem.
8.	Implement Naive Bayes' learning algorithm for the restaurant waiting problem.
9.	Implement passive reinforcement learning algorithm based on adaptive dynamic programming (ADP) for the 3 by 4 world problem
10.	Implement passive reinforcement learning algorithm based on temporal differences (TD) for 3 by 4 world problem.

**Evaluation Pattern****A) Internal Examination: 20 Marks**

<b>Sr No</b>	<b>Criterion</b>	<b>Marks</b>
<b>1</b>	Journals containing minimum 8 practical's which are timely completed with desired output	10
<b>2</b>	Attendance & Practical Performance	10

**B) Semester End Examination: 30 Marks**

**Duration: 1 hrs**

<b>Sr No</b>	<b>Criterion</b>	<b>Marks</b>
<b>1</b>	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
<b>2</b>	Viva	05

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Linux Server Administration</b>
Course Code (refer to student handbook)	<b>USCS502</b>
Class	TYBSc
Semester	V
No of Credits	3
Nature	Theory
Type (applicable to NEP only)	---
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---

**Nomenclature: Linux Server Administration****Course Outcomes:**

- To develop Linux based systems and maintain.
- To install appropriate service on Linux server as per requirement.
- To become proficient in Linux server administration.
- To handle troubleshoot challenging technical problems typically encountered when operating and administering Linux systems

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Introduction:</b>	Technical Summary of Linux Distributions, Managing Software	<b>15</b>
	<b>Single-Host Administration</b>	Managing Users and Groups, Booting and shutting down processes, File Systems, Core System Services, Process of configuring, compiling, Linux Kernel	
	<b>Networking and Security</b>	TCP/IP for System Administrators, basic network Configuration, Linux Firewall (Netfilter), System and network security	
<b>II</b>	<b>Internet Services:</b>	Domain Name System (DNS), File Transfer Protocol (FTP), Apache web server, Simple Mail Transfer Protocol (SMTP), Post Office Protocol and Internet Mail Access Protocol (POP and IMAP), Secure Shell (SSH), Network Authentication, OpenLDAP Server, Samba and LDAP, Network authentication system (Kerberos), Domain Name Service (DNS), Security	<b>15</b>
<b>III</b>	<b>Intranet Services</b>	Network File System (NFS), Samba, Distributed File Systems (DFS), Network Information Service (NIS), Lightweight Directory Access Protocol (LDAP), Dynamic Host Configuration Protocol (DHCP), MySQL, LAMP Applications File Servers, Email Services, Chat Applications, Virtual Private Networking	<b>15</b>



**Learning Resources recommended:****Textbook(s):**

- 1) Linux Administration: A Beginner's Guide, Wale Soyinka, Seventh Edition, McGraw-Hill Education, 2016
- 2) Ubuntu Server Guide, Ubuntu Documentation Team, 2016

**Additional Reference(s):**

- 1) Mastering Ubuntu Server, Jay LaCroix, PACKT Publisher, 2016

**Evaluation Pattern****A . Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Linux Server Administration</b>
Course Code (refer to student handbook)	<b>USCSP501</b>
Class	TYBSc
Semester	V
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:****Lecture/ week : 3**

<b>Practical shall be implemented using Ubuntu Minimum 8 practical to be implemented as a journal work</b>	
1.	Install DHCP Server in Ubuntu 16.04
2.	Initial settings: Add a User, Network Settings, Change to static IP address, Disable IPv6 if not needed, Configure Services, display the list of services which are running, Stop and turn OFF auto-start setting for a service if you don't need it, Sudo Settings
3.	Configure NTP Server (NTPd), Install and Configure NTPd, Configure NTP Client (Ubuntu and Windows)
4.	SSH Server : Password Authentication Configure SSH Server to manage a server from the remote computer, SSH Client : (Ubuntu and Windows)
5.	Install DNS Server BIND, Configure DNS server which resolves domain name or IP address, Install BIND 9, Configure BIND, Limit ranges you allow to access if needed.
6.	Configure DHCP Server, Configure DHCP (Dynamic Host Configuration Protocol) Server, Configure NFS Server to share directories on your Network, Configure NFS Client. (Ubuntu and Windows Client OS)
7.	Configure LDAP Server, Configure LDAP Server in order to share users' accounts in your local networks, Add LDAP User Accounts in the OpenLDAP Server, Configure LDAP Client in order to share users' accounts in your local networks. Install phpLDAPadmin to operate LDAP server via Web browser.
8.	Configure NIS Server in order to share users' accounts in your local networks, Configure NIS Client to bind NIS Server
9.	Install MySQL to configure database server, Install phpMyAdmin to operate MySQL on web browser from Clients.
10.	Install Samba to share folders or files between Windows and Linux.

**Evaluation Pattern**

**A . Internal Examination: 20 Marks**

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B .Semester End Examination: 30 Marks**

**Duration: 1 hrs**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24**

Name of the Course	<b>Software Testing and Quality Assurance</b>
Course Code (refer to student handbook)	<b>USCS503</b>
Class	TYBSc
Semester	V
No of Credits	3
Nature	Theory
Type (applicable to NEP only)	---
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---

**Nomenclature: Software Testing and Quality Assurance****Course Outcomes:**

- To study various software testing methods and strategies.
- To understand a variety of software metrics.
- To identify the defects in software and manage those defects for improvement in quality for given software.
- To design SQA activities, SQA strategy, formal technical review report for software quality control and assurance.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Software Testing and Introduction to quality</b>	Introduction, Nature of errors, an example for Testing, Definition of Quality , QA, QC, QM and SQA , Software Development Life Cycle, Software Quality Factors	<b>15</b>
	<b>Verification and Validation</b>	Definition of V &V , Different types of V & V Mechanisms, Concepts of Software Reviews, Inspection and Walkthrough	
	<b>Software Testing Techniques</b>	Testing Fundamentals, Test Case Design, White Box Testing and its types, Black Box Testing and its types	
<b>II</b>	<b>Software Testing Strategies</b>	Strategic Approach to Software Testing, Unit Testing, Integration Testing, Validation Testing, System Testing	<b>15</b>
	<b>Software Metrics</b>	Concept and Developing Metrics, Different types of Metrics, Complexity metrics	
	<b>Defect Management</b>	Definition of Defects, Defect Management Process,	

		Defect Reporting, Metrics Related to Defects, Using Defects for Process Improvement.	
<b>III</b>	<b>Software Quality Assurance</b>	Quality Concepts, Quality Movement, Background Issues, SQA activities, Software Reviews, Formal Technical Reviews, Formal approaches to SQA, Statistical Quality Assurance, Software Reliability, The ISO 9000 Quality Standards, , SQA Plan , Six sigma, Informal Reviews	<b>15</b>
	<b>Quality Improvement</b>	Introduction, Pareto Diagrams, Cause-effect Diagrams, Scatter Diagrams, Run charts	
	<b>Quality Costs</b>	Defining Quality Costs, Types of Quality Costs, Quality Cost Measurement, Utilizing Quality Costs for Decision-Making	

**Learning Resources recommended:****Textbook(s):**

1. Software Engineering for Students, A Programming Approach, Douglas Bell, 4<sup>th</sup> Edition,, Pearson Education, 2005
2. Software Engineering – A Practitioners Approach, Roger S. Pressman, 5<sup>th</sup> Edition, Tata McGraw Hill, 2001
3. Quality Management, Donna C. S. Summers, 5<sup>th</sup> Edition, Prentice-Hall, 2010.
4. Total Quality Management, Dale H. Besterfield, 3<sup>rd</sup> Edition, Prentice Hall, 2003.

**Additional Reference(s):**

1. Software engineering: An Engineering approach, J.F. Peters, W. Pedrycz , John Wiley,2004
2. Software Testing and Quality Assurance Theory and Practice, Kshirsagar Naik, Priyadarshi Tripathy , John Wiley & Sons, Inc. , Publication, 2008
3. Software Engineering and Testing, B. B. Agarwal, S. P. Tayal, M. Gupta, Jones and Bartlett Publishers, 2010

**Evaluation Pattern****A . Internal Evaluation: 40 marks**

<b>Method</b>	<b>Marks</b>
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B . Semester End Evaluation: 60 marks (Paper Pattern) Duration: 2 hrs**

<b>Question No</b>	<b>Unit</b>	<b>Options</b>	<b>Marks</b>
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Software Testing and Quality Assurance</b>
Course Code (refer to student handbook)	<b>USCSP501</b>
Class	TYBSc
Semester	V
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:****Lecture/ week : 3**

<b>Practical shall be implemented using Netbeans and Selenium IDE Minimum 8 practical to be implemented as a journal work</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
1.	Install Selenium IDE; Write a test suite containing minimum 4 test cases for different formats.
2.	Conduct a test suite for any two web sites.
3.	Install Selenium server (Selenium RC) and demonstrate it using a script in Java/PHP.
4.	Write and test a program to login a specific web page.
5.	Write and test a program to update 10 student records into table into Excel file
6.	Write and test a program to select the number of students who have scored more than 60 in any one subject (or all subjects).
7.	Write and test a program to provide total number of objects present / available on the page.
8.	Write and test a program to get the number of items in a list / combo box.
9.	Write and test a program to count the number of check boxes on the page checked and unchecked count.
10.	Load Testing using JMeter, Android Application testing using Appium Tools, Bugzilla Bug tracking tools.

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

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks** **Duration: 1 hrs**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05



## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Information and Network Security</b>
Course Code (refer to student handbook)	<b>USCS504</b>
Class	TYBSC
Semester	V
No of Credits	3
Nature	Theory
Type (applicable to NEP only)	----
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----

**Nomenclature:** Information and Network Security**Course Outcomes:**

- To study the principles and practices of cryptographic techniques.
- To understand a variety of generic security threats and vulnerabilities
- To identify & analyze particular security problems for a given application.
- To understand various protocols for network security to protect against the threats in a network

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Introduction</b>	Security Trends, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms	<b>15</b>
	<b>Classical Encryption Techniques</b>	Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Steganography, Block Cipher Principles, The Data Encryption Standard, The Strength of DES, AES (round details not expected), Multiple Encryption and Triple DES, Block Cipher Modes of Operation, Stream Ciphers	
	<b>Public-Key Cryptography and RSA</b>	Principles of Public-Key Cryptosystems, The RSA Algorithm	
<b>II</b>	<b>Key Management:</b>	Public-Key Cryptosystems, Key Management, Diffie-Hellman Key Exchange	<b>15</b>
	<b>Message Authentication and Hash Functions:</b>	Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and Macs, Secure Hash Algorithm, HMAC	
	<b>Digital Signatures and Authentication:</b>	Digital Signatures, Authentication Protocols, Digital Signature Standard	
	<b>Authentication</b>	Kerberos, X.509 Authentication, Public-Key	

	<b>Applications:</b>	Infrastructure	
<b>III</b>	<b>Electronic Mail Security</b>	Pretty Good Privacy, S/MIME	<b>15</b>
	<b>IP Security</b>	Overview, Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations, Key Management	
	<b>Web Security</b>	Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction	
	<b>Intrusion</b>	Intruders, Intrusion Techniques, Intrusion Detection	
	<b>Malicious Software</b>	Viruses and Related Threats, Virus Countermeasures, DDOS	
	<b>Firewalls</b>	Firewall Design Principles, Types of Firewalls	

**Learning Resources recommended:****Textbook(s):**

1. Cryptography and Network Security: Principles and Practice 5th Edition, William Stallings, Pearson,2010

**Additional Reference(s):**

1. Cryptography and Network Security, Atul Kahate, Tata McGraw-Hill, 2013.
2. Cryptography and Network, Behrouz A Fourouzan, Debdeep Mukhopadhyay, 2<sup>nd</sup> Edition, TMH,2011

**Evaluation Pattern****A . Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modularobject-orienteddynamiclearning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern) Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Information and Network security</b>
Course Code (refer to student handbook)	<b>USCSP502</b>
Class	TYBSc
Semester	V
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:****Lecture/ week: 3**

<b>Practical shall be implemented using Netbeans Minimum 8 practical to be implemented as a journal work</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
1.	Write programs to implement the following Substitution Cipher Techniques: - Caesar Cipher - Monoalphabetic Cipher
2.	Write programs to implement the following Substitution Cipher Techniques: - Vernam Cipher - Playfair Cipher
3.	Write programs to implement the following Transposition Cipher Techniques: - Rail Fence Cipher - Simple Columnar Technique
4.	Write program to encrypt and decrypt strings using - DES Algorithm - AES Algorithm
5.	Write a program to implement RSA algorithm to perform encryption / decryption of a given string.
6.	Write a program to implement the Diffie-Hellman Key Agreement algorithm to generate symmetric keys.
7.	Write a program to implement the MD5 algorithm compute the message digest.
8.	Write a program to calculate HMAC-SHA1 Signature
9.	Write a program to implement SSL.
10.	Configure Windows Firewall to block: - A port - An Program - A website

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

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks****Duration: 1 hrs**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>IoT Architecture</b>
Course Code (refer to student handbook)	<b>USCS505</b>
Class	TYBSC
Semester	V
No of Credits	02
Nature	Theory
Type (applicable to NEP only)	-----
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-----

**Nomenclature: IoT Architecture****Course Outcomes:**

- To study architecture of IoT
- To design & develop IoT Devices.
- To study M2M Communications.
- To study IoT analytics.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>IoT-An Architectural Overview</b>	Building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.	<b>15</b>
	<b>IoT Architecture-State of the Art</b>	Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views	
<b>II</b>	<b>IoT Data Link Layer and Network Layer Protocols</b>	PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART,Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy DASH7	<b>15</b>
	<b>Network Layer</b>	IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP	
<b>III</b>	<b>Transport layer protocols</b>	Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS)	<b>15</b>
	<b>Session layer</b>	Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT	
	<b>Service layer protocols</b>	Service Layer -oneM2M, ETSI M2M, OMA, BBF	

**Learning Resources recommended:****Textbook(s):**

1. From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, 1st Edition, Academic Press, 2014.
2. Learning Internet of Things, Peter Waher, PACKT publishing, BIRMINGHAM – MUMBAI, 2015

**Additional References(s):**

1. Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, Daniel Minoli, Wiley Publications, 2013
2. Internet of Things (A Hands-on Approach), Vijay Madiseti and Arshdeep Bahga, 1st Edition, VPT, 2014.
3. [http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot\\_prot/index.html](http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html)

**Evaluation Pattern****A . Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b> (Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>IoT Architecture</b>
Course Code (refer to student handbook)	<b>USCSP502</b>
Class	TYBSc
Semester	V
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:****Lecture/ week : 3**

<b>Practical shall be implemented using Ubuntu Minimum 8 practical to be implemented as a journal work</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
1.	<p>a) Edit text files with nano and cat editor, Learn sudo privileges and Unix shell commands such as cd , ls , cat, etc</p> <p>b) Learn to set dynamic and static IP. Connect to an Ethernet and WiFi network. Learn to vnc and ssh into a raspberry pi using vnc and putty from a different computer on the network.</p> <p>c) Write a basic bash script to open programs in kiosk mode. Learn how to autostart programs on boot.</p>
2.	Run the node red editor and run simple programs and trigger gpios. Use basic nodes such as inject, debug, gpio
3.	Open the python idle editor and run simple Python scripts such as to print Fibonacci numbers, string functions. Learn how to install modules using Pip and write functions
4.	Setup a physical button switch and trigger an led in node red and python w debounce
5.	Write simple JavaScript functions in Node-Red simple HTTP server page using node red
6.	Setup a TCP server and client on a raspberry pi using Python modules to send messages and execute shell commands from within python such as starting another application
7.	Trigger a set of led Gpios on the pi via a Python Flask web server
8.	Interface the raspberry pi with a 16x2 LCD display and print values.
9.	Setup a Mosquitto MQTT server and client and write a Python script to communicate data between Pi's.
10.	Interface with an Accelerometer Gyro Mpu6050 on the i2c bus and send sensor values over the

**Evaluation Pattern**

**A. Internal Examination: 20 Marks**

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks**

**Duration: 1 hrs**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05



## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Web Services</b>
Course Code (refer to student handbook)	<b>USCS506</b>
Class	TYBSC
Semester	V
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	--
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--

**Nomenclature: Web Services****Course Outcomes:**

- To study SOAP based web services and associated standards such as WSDL.
- To design SOAP based / RESTful / WCF services.
- To study web services which deal with Security and QoS issues.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Web services basics</b>	What Are Web Services? Types of Web Services Distributed computing infrastructure, overview of XML, SOAP, Building Web Services with JAX-WS, Registering and Discovering Web Services, Service Oriented Architecture, Web Services Development Life Cycle, Developing and consuming simple Web Services across platform	<b>15</b>
<b>II</b>	<b>The REST Architectural style</b>	Introducing HTTP, The core architectural elements of a RESTful system, Description and discovery of RESTful web services, Java tools and frameworks for building RESTful web services, JSON message format and tools and frameworks around JSON, Build RESTful web services with JAX-RS APIs, The Description and Discovery of RESTful Web Services, Design guidelines for building RESTful web services, Secure RESTful web services	<b>15</b>
<b>III</b>	<b>Developing Service-Oriented Applications with WCF</b>	What Is Windows Communication Foundation, Fundamental Windows Communication Foundation Concepts, Windows Communication Foundation Architecture, WCF and .NET Framework Client Profile, Basic WCF Programming, WCF Feature Details. Web Service QoS	<b>15</b>

**Learning Resources recommended:****Textbook(s):**

1. Web Services: Principles and Technology, Michael P. Papazoglou, Pearson Education Limited, 2008
2. RESTful Java Web Services, Jobinesh Purushothaman, PACKT Publishing, 2nd Edition, 2015
3. Developing Service-Oriented Applications with WCF, Microsoft, 2017  
<https://docs.microsoft.com/en-us/dotnet/framework/wcf/index>

**Additional Reference(s):**

1. Leonard Richardson and Sam Ruby, RESTful Web Services, O'Reilly, 2007
2. The Java EE 6 Tutorial, Oracle, 2013

**Evaluation Pattern****A. Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)      Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Web Services</b>
Course Code (refer to student handbook)	<b>USCSP502</b>
Class	TYBSc
Semester	V
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:****Lecture/ week : 3**

<b>Practical shall be implemented using Netbeans and Visual Studio Minimum 8 practical to be implemented as a journal work</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
1.	Write a program to implement to create a simple web service that converts the temperature from Fahrenheit to Celsius and vice a versa.
2.	Write a program to implement the operation can receive request and will return a response in two ways. a) One - Way operation b) Request –Response
3.	Write a program to implement business UDDI Registry entry.
4.	Develop client which consumes web services developed in different platform.
5.	Write a JAX-WS web service to perform the following operations. Define a Servlet / JSP that consumes the web service.
6.	Define a web service method that returns the contents of a database in a JSON string. The contents should be displayed in a tabular format.
7.	Define a RESTful web service that accepts the details to be stored in a database and performs CRUD operation
8.	Implement a typical service and a typical client using WCF.
9.	Use WCF to create a basic ASP.NET Asynchronous JavaScript and XML (AJAX) service.
10.	Demonstrates using the binding attribute of an endpoint element in WCF.

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

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks****Duration: 1 hrs**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Game Programming</b>
Course Code (refer to student handbook)	<b>USCS507</b>
Class	TYBSc
Semester	V
No of Credits	3
Nature	Theory
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

**Nomenclature: Game Programming****Course Outcomes:**

- To study Graphics and gaming concepts.
- To study modern techniques of game designing to implement on windows.
- To understand different game engines and getting knowledge about Unity (Game Engine).
- To understand concepts of AR, VR and MR.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I (Mathematics for Computer Graphics, DirectX Kickstart)</b>	<b>Cartesian Coordinate system</b>	The Cartesian XY-plane, Function Graphs, Geometric Shapes, Polygonal Shapes, Areas of Shapes, Theorem of Pythagoras in 2D, Coordinates, Theorem of Pythagoras in 3D, 3D Polygons, Euler's Rule	<b>15</b>
	<b>Vectors</b>	Vector Manipulation, multiplying a Vector by a Scalar, Vector Addition and Subtraction, Position Vectors, Unit Vectors, Cartesian Vectors, Vector Multiplication, Scalar Product, Example of the Dot Product, The Dot Product in Lighting Calculations, The Dot Product in Back-Face Detection, The Vector Product, The Right-Hand Rule, deriving a Unit Normal Vector for a Triangle Areas, Calculating 2D Areas	
	<b>Transformations</b>	2D Transformations, Matrices, Homogeneous Coordinates, 3D Transformations, Change of Axes, Direction Cosines, rotating a Point about an Arbitrary Axis, Transforming Vectors, Determinants, Perspective Projection, Interpolation	
	<b>DirectX</b>	Understanding GPU and GPU architectures. How they are different from CPU Architectures? Understanding how to solve by GPU?	
	<b>Introduction To</b>	COM, Textures and Resources Formats, The swap chain and Page flipping, Depth Buffering, Texture	

<b>II</b> <b>(DirectX Pipeline and Programming)</b>	<b>DirectX 11</b>	Resource Views, Multisampling Theory and MS in Direct3D, Feature Levels	<b>15</b>
	<b>Direct3D 11 Rendering Pipeline</b>	Overview, Input Assembler Stage (IA), Vertex Shader Stage (VS), The Tessellation Stage (TS), Geometry Shader Stage (GS), Pixel Shader Stage (PS), Output merger Stage (OM) Understanding Meshes or Objects, Texturing, Lighting, Blending.	
	<b>Interpolation and Character Animation, Trigonometry</b>	The Trigonometric Ratios, Inverse Trigonometric Ratios, Trigonometric Relationships, The Sine Rule, The Cosine Rule, Compound Angles, Perimeter Relationships	
	<b>Interpolation</b>	Linear Interpolant, Non-Linear Interpolation, Trigonometric Interpolation, Cubic Interpolation, Interpolating Vectors, Interpolating Quaternions	
	<b>Curves</b>	Circle, Bezier, B-Splines	
	<b>Analytic Geometry</b>	Review of Geometry, 2D Analytic Geometry, Intersection Points, Point in Triangle, and Intersection of circle with straight line.	
	<b>III</b>	<b>Introduction to Rendering Engines</b>	
<b>Unity Engine, Multi-platform publishing, VR + AR</b>		Introduction and working in Unity, 2D, Graphics, Physics, Scripting, Animation, Timeline, Multiplayer and Networking, UI, Navigation and Pathfinding, XR, Publishing	
<b>Scripting</b>		Scripting Overview, Scripting Tools and Event Overview	
<b>XR</b>		VR, AR, MR, Conceptual Differences. SDK, Devices	

**Learning Resources recommended:****Text Book(s):**

- 1) Mathematics for Computer Graphics, John Vince, Springer-Verlag London, 5th Edition, 2017
- 2) Mathematics for 3D Game Programming and Computer Graphic, Eric Lengyel, Delmar Cengage Learning, Delmar Cengage Learning, 2011
- 3) Introduction To 3D Game Programming With DirectX® 11, Frank D Luna, Mercury Learning and Information, 2012.
- 4) <https://docs.unity3d.com/Manual/index.html> - Free

**Additional Reference(s):**

- 1) Computer Graphics, C Version, Donald Hern and Pauline Baker, Pearson Education, 2nd Edition, 1997
- 2) HLSL Development Cookbook, Doron Feinstein, PACKT Publishing, 2013

**Evaluation Pattern****A . Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>● It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modularobject-orienteddynamiclearning environment)</li> <li>● The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>● Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)****Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Game Programming</b>
Course Code (refer to student handbook)	<b>USCSP504</b>
Class	TYBSc
Semester	V
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Nomenclature: Game Programming****Course Outcomes:**

- To study Graphics and gaming concepts.
- To study modern techniques of game designing to implement on windows.
- To understand different game engines and getting knowledge about Unity (Game Engine).
- To understand concepts of AR, VR and MR.

**Curriculum:****Lecture/ week : 3**

<b>Practical shall be implemented using Unity and DirectX Minimum 8 practical to be implemented as a journal work</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
1.	Setup DirectX 11, Window Framework and Initialize Direct3D Device
2.	Buffers, Shaders and HLSL (Draw a triangle using Direct3D 11)
3.	Texturing (Texture the Triangle using Direct 3D 11)
4.	Lightning (Programmable Diffuse Lightning using Direct3D 11)
5.	Specular Lightning (Programmable Spot Lightning using Direct3D 11)
6.	Loading models into DirectX 11 and rendering.
7.	<a href="https://unity3d.com/learn/tutorials/s/2d-ufo-tutorial">https://unity3d.com/learn/tutorials/s/2d-ufo-tutorial</a>
8.	<a href="https://unity3d.com/learn/tutorials/s/space-shooter-tutorial">https://unity3d.com/learn/tutorials/s/space-shooter-tutorial</a>
9.	<a href="https://unity3d.com/learn/tutorials/s/roll-ball-tutorial">https://unity3d.com/learn/tutorials/s/roll-ball-tutorial</a>
10.	<a href="https://unity3d.com/learn/tutorials/topics/vr/introduction?playlist=22946">https://unity3d.com/learn/tutorials/topics/vr/introduction?playlist=22946</a>



**Evaluation Pattern**

**A. Internal Examination: 20 Marks**

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks**

**Duration: 1 hrs**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

**I. Project(USCSP503)**

The evaluation of the project will include a viva voce, which will assess the project based on the following parameters:

- **Documentation – 10 Marks:** The completeness, accuracy, and professionalism of the project documentation, including the project report and supporting materials, will be considered.
- **Quality of the Project – 10 Marks:** The overall quality of the project, including its design, implementation, and user experience, will be evaluated.
- **Working of the Project – 10 Marks:** The functionality and performance of the project will be assessed to determine how well it meets the specified requirements and objectives.
- **Project Presentation – 10 Marks:** The clarity, organization, and effectiveness of the project presentation will be evaluated.
- **Viva – 10 Marks:** The viva voce session will provide an opportunity for the student to demonstrate their knowledge and understanding of the project, as well as to answer questions and engage in a discussion with the evaluators.

**Please refer to Project implementation Guidelines**

*Revised Syllabus of Courses of B.Sc. Computer Science Programme at Semester VI  
Implementation Year 2023-2024*

**Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24**

Name of the Course	<b>Wireless Sensor Networks and Mobile Communication</b>
Course Code (refer to student handbook)	<b>USCS601</b>
Class	TYBSc
Semester	VI
No of Credits	3
Nature	Theory
Type (applicable to NEP only)	----
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----

**Nomenclature:** Wireless Sensor Networks and Mobile Communication

**Course Outcomes:**

- After completion of this course, learner should be able to list various applications of wireless sensor networks, describe the concepts, protocols, design, implementation and use of wireless sensor networks.
- Also implement and evaluate new ideas for solving wireless sensor network design issues.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Introduction</b>	Introduction to Sensor Networks, unique constraints and challenges. Advantage of Sensor Networks, Applications of Sensor Networks, Mobile Adhoc NETWORKS (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks.	<b>15</b>
	<b>Sensor Node Hardware and Network Architecture</b>	Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC. Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.	
<b>II</b>	<b>Medium Access Control Protocols</b>	Fundamentals of MAC Protocols, MAC Protocols for WSNs, Sensor-MAC Case Study.	

	<b>Routing Protocols</b>	Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless	<b>15</b>
	<b>Transport Control Protocols</b>	Sensor Networks, Routing Strategies in Wireless Sensor Networks. Traditional Transport Control Protocols, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols, Performance of Transport Control Protocols.	
<b>III</b>	<b>Introduction, Wireless Transmission and Medium Access Control</b>	Applications, A short history of wireless communication.	<b>15</b>
	<b>Wireless Transmission:</b>	Frequency for radio transmission, Signals, Antennas, Signal propagation, Multiplexing, Modulation, Spread spectrum, Cellular systems.	
	<b>Telecommunication , Satellite and Broadcast Systems: GSM</b>	Mobile services, System architecture, Radio interface, Protocols, Localization And Calling, Handover, security, New data services; DECT: System architecture, Protocol architecture; ETRA, UMTS and IMT- 2000. Satellite Systems: History, Applications, Basics: GEO, LEO, MEO; Routing, Localization, Handover.	

**Learning Resources recommended:****Textbook(s):**

- 1) Protocols and Architectures for Wireless Sensor Network, Holger Kerl, Andreas Willig, John Wiley and Sons, 2005
- 2) Wireless Sensor Networks Technology, Protocols, and Applications ,Kazem Sohraby, Daniel Minoli and Taieb Znati, John Wiley & Sons, 2007
- 3) Mobile communications, Jochen Schiller, 2<sup>nd</sup> Edition, Addison wisely , Pearson Education, 2012

**Additional Reference(s):**

- 1) Fundamentals of Wireless Sensor Networks, Theory and Practice, Walteneus Dargie, Christian Poellabauer , Wiley Series on wireless Communication and Mobile Computing, 2011
- 2) Networking Wireless Sensors, Bhaskar Krishnamachari , Cambridge University Press, 2005

**Evaluation Pattern****A . Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modularobject-orienteddynamiclearning environment)</li> <li>The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks(Paper Pattern)****Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Wireless Sensor Networks and Mobile Communication</b>
Course Code (refer to student handbook)	<b>USCSP601</b>
Class	TYBSc
Semester	VI
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:****Lecture/ week : 3**

<b>Practical shall be implemented using OMNeT++ and CICS0 Minimum 8 practical to be implemented as a journal work</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
1.	Understanding the Sensor Node Hardware. (For Eg. Sensors, Nodes(Sensor mote), Base Station, Graphical User Interface.)
2.	Exploring and understanding TinyOS computational concepts:- Events, Commands and Task. - nesC model - nesC Components
3.	Understanding TOSSIM for - Mote-mote radio communication - Mote-PC serial communication
4.	Create and simulate a simple adhoc network
5.	Understanding, Reading and Analyzing Routing Table of a network.
6.	Create a basic MANET implementation simulation for Packet animation and Packet Trace.
7.	Implement a Wireless sensor network simulation.
8.	Create MAC protocol simulation implementation for wireless sensor Network.
9.	Simulate Mobile Adhoc Network with Directional Antenna
10.	Create a mobile network using Cell Tower, Central Office Server, Web browser and Web Server. Simulate connection between them.

**Evaluation Pattern:**

**A. Internal Examination: 20 Marks**

Sr No	Criterion	Marks
1	Journals containing minimum 8 practicals which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks**

**Duration: 1 hrs**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Cloud Computing</b>
Course Code (refer to student handbook)	<b>USCS602</b>
Class	TYBSc
Semester	VI
No of Credits	3
Nature	Theory
Type (applicable to NEP only)	---
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---

**Nomenclature: Cloud Computing****Course Outcomes:**

- After successful completion of this course, learners should be able to articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing using open source technology.
- Learners should be able to identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
- They should explain the core issues of cloud computing such as security, privacy, and interoperability.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Introduction</b>	Introduction to Cloud Computing, Characteristics and benefits of Cloud Computing, Basic concepts of Distributed Systems, Web 2.0, Service-Oriented Computing, Utility-Oriented Computing. Elements of Parallel Computing. Elements of Distributed Computing. Technologies for Distributed Computing. Cloud Computing Architecture. The cloud reference model. Infrastructure as a service. Platform as a service. Software as a service. Types of clouds.	<b>15</b>
<b>II</b>	<b>Taxonomy of Virtualization Techniques.</b>	Characteristics of Virtualized Environments. Taxonomy of Virtualization Techniques. Virtualization and Cloud Computing. Pros and Cons of Virtualization. Virtualization using KVM, Creating virtual machines, oVirt - management tool for virtualization environment. Open challenges of Cloud Computing	<b>15</b>
<b>III</b>	<b>Introduction to OpenStack</b>	Introduction to OpenStack, OpenStack test-drive, Basic OpenStack operations, OpenStack CLI and APIs, Tenant model operations, Quotas, Private cloud building blocks, Controller deployment, Networking deployment, Block Storage deployment, Compute deployment, deploying and utilizing OpenStack in production environments, Building a production environment, Application orchestration using OpenStack Heat	<b>15</b>



**Learning Resources recommended:**

**Textbook(s):**

- 1) Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi, Tata McGraw Hill Education Private Limited, 2013
- 2) OpenStack in Action, V. K. CODY BUMGARDNER, Manning Publications Co,2016

**Additional Reference(s):**

- 1) OpenStack Essentials, Dan Radez, PACKT Publishing, 2015
- 2) OpenStack Operations Guide, Tom Fifield, Diane Fleming, Anne Gentle, Lorin Hochstein, Jonathan Proulx, Everett Toews, and Joe Topjian, O'Reilly Media, Inc., 2014
- 3) <https://www.openstack.org>

**Evaluation Pattern**

**A . Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)**

**Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Cloud Computing</b>
Course Code (refer to student handbook)	<b>USCSP601</b>
Class	TYBSc
Semester	VI
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	----
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----

**Curriculum:****Lecture/ week : 3**

Sr. No.	<b>Practical shall be implemented using Google Cloud Minimum 8 practical to be implemented as a journal work</b>
1.	Study and implementation of Infrastructure as a Service.
2.	Installation and Configuration of virtualization using KVM.
3.	Study and implementation of Infrastructure as a Service
4.	Study and implementation of Storage as a Service
5.	Study and implementation of identity management
6.	Study Cloud Security management
7.	Write a program for web feed.
8.	Study and implementation of Single-Sign-On.
9.	User Management in Cloud.
10.	Case study on Amazon EC2/Microsoft Azure/Google Cloud Platform

**Evaluation Pattern****A) Internal Examination: 20 Marks**

Sr No	Criterion	Marks
1	Journals containing minimum 8 practicals which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B) Semester End Examination: 30 Marks****Duration: 1 hrs**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Cyber Forensics</b>
Course Code (refer to student handbook)	<b>USCS603</b>
Class	TYBSc
Semester	VI
No of Credits	3
Nature	Theory
Type (applicable to NEP only)	--
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--

**Nomenclature: Cyber Forensics****Course Outcomes:**

- The student will be able to plan and prepare for all stages of an investigation
- The Learner will able to do the detection, initial response and management interaction related cyber problems.
- Also investigate various media to collect evidence, report them in a way that would be acceptable in the court of law.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Computer Forensics</b>	Introduction to Computer Forensics and standard procedure, Incident Verification and System Identification ,Recovery of Erased and damaged data, Disk Imaging and Preservation, Data Encryption and Compression, Automated Search Techniques, Forensics Software	<b>15</b>
	<b>Network Forensic</b>	Introduction to Network Forensics and tracking network traffic, Reviewing Network Logs, Network Forensics Tools, Performing Live Acquisitions, Order of Volatility, Standard Procedure	
	<b>Cell Phone and Mobile Device Forensics</b>	Overview, Acquisition Procedures for Cell Phones and Mobile Devices	
<b>II</b>	<b>Internet Forensic</b>	<b>Introduction</b> to Internet Forensics, World Wide Web Threats, Hacking and Illegal access, Obscene and Incident transmission, Domain Name Ownership Investigation, Reconstructing past internet activities and events	<b>15</b>
	<b>E-mail Forensics</b>	e-mail analysis, e-mail headers and spoofing, Laws against e-mail Crime, <b>Messenger Forensics:</b> Yahoo Messenger	
	<b>Social Media Forensics</b>	Social Media Investigations	
	<b>Browser Forensics</b>	Cookie Storage and Analysis, Analyzing Cache and temporary internet files, Web browsing activity	

		reconstruction	
<b>III</b>	<b>Investigation, Evidence presentation and Legal aspects of Digital Forensics</b>	Authorization to collect the evidence , Acquisition of Evidence, Authentication of the evidence, Analysis of the evidence, Reporting on the findings, Testimony	<b>15</b>
	<b>Introduction to Legal aspects of Digital Forensics</b>	Laws & regulations, Information Technology Act, Giving Evidence in court, Case Study – Cyber Crime cases, Case Study – Cyber Crime cases	

**Learning Resources recommended:****Textbook(s):**

1. Guide to computer forensics and investigations, Bill Nelson, Amelia Philips and Christopher Steuart, course technology, 5th Edition, 2015

**Additional Reference(s):**

2. Incident Response and computer forensics, Kevin Mandia, Chris Prosise, Tata McGrawHill, 2<sup>nd</sup> Edition, 2003

**Evaluation Pattern****A . Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b>	20
<ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	
<b>Assignment/ Case study/ Presentations</b>	10
<ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern) Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

## Syllabus for TY Computer Science Autonomous from the year 2023-24

Name of the Course	<b>Cyber Forensics</b>
Course Code (refer to student handbook)	<b>USCSP601</b>
Class	TYBSc
Semester	VI
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:****Lecture/ week : 3**

**Practical shall be implemented using Wire Shark, Sysinternals tool ,FTK imager , FTK autopsy , Browser history examiner , Belkasoft RAM capturer.  
Minimum 8 practical to be implemented as a journal work.**

Sr. No.	Practical Title
1.	Creating a Forensic Image using FTK Imager/Encase Imager : <ul style="list-style-type: none"> <li>- Creating Forensic Image</li> <li>- Check Integrity of Data</li> <li>- Analyze Forensic Image</li> </ul>
2.	Data Acquisition: <ul style="list-style-type: none"> <li>- Perform data acquisition using:</li> <li>- USB Write Blocker + Encase Imager</li> <li>- SATA Write Blocker + Encase Imager</li> <li>- Falcon Imaging Device</li> </ul>
3.	Forensics Case Study: <ul style="list-style-type: none"> <li>- Solve the Case study (image file) provide in lab using Encase Investigator or Autopsy</li> </ul>
4.	Capturing and analyzing network packets using Wireshark (Fundamentals) : <ul style="list-style-type: none"> <li>- Identification the live network</li> <li>- Capture Packets</li> <li>- Analyze the captured packets</li> </ul>
5.	Analyze the packets provided in lab and solve the questions using Wireshark : <ul style="list-style-type: none"> <li>- What web server software is used by www.snopes.com?</li> <li>- About what cell phone problem is the client concerned?</li> <li>- According to Zillow, what instrument will Ryan learn to play?</li> <li>- How many web servers are running Apache?</li> <li>- What hosts (IP addresses) think that jokes are more entertaining when they are explained?</li> </ul>
6.	Using Sysinternals tools for Network Tracking and Process Monitoring : <ul style="list-style-type: none"> <li>- Check Sysinternals tools</li> <li>- Monitor Live Processes</li> <li>- Capture RAM</li> <li>- Capture TCP/UDP packets</li> <li>- Monitor Hard Disk</li> </ul>

	<ul style="list-style-type: none"> <li>- Monitor Virtual Memory</li> <li>- Monitor Cache Memory</li> </ul>
7.	Recovering and Inspecting deleted files <ul style="list-style-type: none"> <li>- Check for Deleted Files</li> <li>- Recover the Deleted Files</li> <li>- Analyzing and Inspecting the recovered files</li> <li>- Perform this using recovery option in ENCASE and also Perform manually through command line</li> </ul>
8.	Acquisition of Cell phones and Mobile devices
9.	Email Forensics <ul style="list-style-type: none"> <li>- Mail Service Providers</li> <li>- Email protocols</li> <li>- Recovering emails</li> <li>- Analyzing email header</li> </ul>
10.	Web Browser Forensics <ul style="list-style-type: none"> <li>- Web Browser working</li> <li>- Forensics activities on browser</li> <li>- Cache / Cookies analysis</li> <li>- Last Internet activity</li> </ul>

**Evaluation Pattern**

**A. Internal Examination: 20 Marks**

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B. Semester End Examination: 30 Marks**

**Duration: 1 hrs**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Information Retrieval</b>
Course Code (refer to student handbook)	<b>USCS604</b>
Class	TYBSc
Semester	VI
No of Credits	3
Nature	Theory
Type (applicable to NEP only)	---
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---

**Nomenclature: Information Retrieval****Course Outcomes:**

- After completion of this course, learners should get an understanding of the field of information retrieval and its relationship to search engines.
- It will give the learner an understanding to apply information retrieval models.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Introduction to Information Retrieval</b>	Introduction, History of IR, Components of IR, and Issues related to IR, Boolean retrieval, Dictionaries and tolerant retrieval.	<b>15</b>
<b>II</b>	<b>Link Analysis and Specialized Search</b>	Link Analysis, hubs and authorities, Page Rank and HITS algorithms, Similarity, Hadoop & Map Reduce, Evaluation, Personalized search, Collaborative filtering and content-based recommendation of documents and products, handling “invisible” Web, Snippet generation, Summarization, Question Answering, Cross- Lingual Retrieval.	<b>15</b>
<b>III</b>	<b>Web Search Engine</b>	Web search overview, web structure, the user, paid placement, search engine optimization/spam, Web size measurement, search engine optimization/spam, Web Search Architectures.	<b>15</b>
	<b>XML retrieval</b>	Basic XML concepts, Challenges in XML retrieval, A vector space model for XML retrieval, Evaluation of XML retrieval, Text-centric versus data-centric XML retrieval.	

**Learning Resources recommended:**

**Text book(s):**

- 1) Introduction to Information Retrieval, C. Manning, P. Raghavan, and H. Schütze, Cambridge University Press, 2008
- 2) Modern Information Retrieval: The Concepts and Technology behind Search, Ricardo Baeza -Yates and Berthier Ribeiro – Neto, 2<sup>nd</sup> Edition, ACM Press Books 2011.
- 3) Search Engines: Information Retrieval in Practice, Bruce Croft, Donald Metzler and Trevor Strohman, 1<sup>st</sup> Edition, Pearson, 2009.

**Additional Reference(s):**

- 1) Information Retrieval Implementing and Evaluating Search Engines, Stefan Büttcher, Charles L. A. Clarke and Gordon V. Cormack, The MIT Press; Reprint edition (February 12, 2016)

**Evaluation Pattern**

**A . Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>● It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>● The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>● Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behaviour</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern)**

**Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15



## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Information Retrieval</b>
Course Code (refer to student handbook)	<b>USCSP602</b>
Class	TYBSc
Semester	VI
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:****Lecture/ week : 3**

<i>Practical may be done using software/tools like Python / Java / Hadoop.</i> <b>Minimum 8 practical to be implemented as a journal work.</b>	
Sr. No.	Practical Title
1.	Write a program to demonstrate bitwise operation.
2.	Implement Page Rank Algorithm.
3.	Implement Dynamic programming algorithm for computing the edit distance between strings s1 and s2. (Hint. Levenshtein Distance)
4.	Write a program to Compute Similarity between two text documents.
5.	Write a map-reduce program to count the number of occurrences of each alphabetic character in the given dataset. The count for each letter should be case-insensitive (i.e., include both upper-case and lower-case versions of the letter; Ignore non-alphabetic characters).
6.	Implement a basic IR system using Lucene.
7.	Write a program for Pre-processing of a Text Document: stop word removal.
8.	Write a program for mining Twitter to identify tweets for a specific period and identify trends and named entities.
9.	Write a program to implement a simple web crawler.
10.	Write a program to parse XML text, generate Web graph and compute topic specific page rank.

**Evaluation Pattern****A) Internal Examination: 20 Marks**

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B) Semester End Examination: 30 Marks**

**Duration: 1 hrs**

<b>Sr No</b>	<b>Criterion</b>	<b>Marks</b>
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Digital Image Processing</b>
Course Code (refer to student handbook)	<b>USCS605</b>
Class	TYBSc
Semester	VI
No of Credits	3
Nature	Theory
Type (applicable to NEP only)	----
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---

**Nomenclature: Digital Image Processing****Course Outcomes:**

- Learner should review the fundamental concepts of a digital image processing system.
- Analyze the images in the frequency domain using various transforms. Evaluate the techniques for image enhancement and image segmentation.
- Apply various compression techniques. They will be familiar with basic image processing techniques for solving real problems.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Introduction to Image-processing System</b>	Introduction, Image Sampling, Quantization, Resolution, Human Visual Systems, Elements of an Image-processing System, Applications of Digital Image Processing	<b>15</b>
	<b>2D Signals and Systems</b>	2D signals, separable sequence, periodic sequence, 2D systems, classification of 2D systems, 2D Digital filter	
	<b>Convolution and Correlation</b>	2D Convolution through graphical method, Convolution through 2D Z—transform, 2D Convolution through matrix analysis, Circular Convolution, Applications of Circular Convolution, 2D Correlation	
	<b>Image Transforms</b>	Need for transform, image transforms, Fourier transform, 2D Discrete Fourier Transform, Properties of 2D DFT, Importance of Phase, Walsh transform, Hadamard transform, Haar transform, Slant transform, Discrete Cosine transform, KL transform	
<b>II</b>	<b>Image Enhancement</b>	Image Enhancement in spatial domain, Enhancement through Point operations, Histogram manipulation, Linear and nonlinear Gray Level Transformation, local or neighborhood operation, Median Filter, Spatial domain High pass filtering, Bit-plane slicing, Image Enhancement in frequency domain, Homomorphic filter, Zooming operation,	<b>15</b>

		Image Arithmetic	
	<b>Binary Image processing</b>	Mathematical morphology, Structuring elements, Morphological image processing, Logical operations, Morphological operations, Dilation and Erosion, Distance Transform	
	<b>Colour Image processing</b>	Colour images, Colour Model, Colour image quantization, Histogram of a colour image	
<b>III</b>	<b>Image Segmentation</b>	Image segmentation techniques, Region approach, Clustering techniques, Thresholding, Edge-based segmentation, Edge detection, Edge Linking, Hough Transform	<b>15</b>
	<b>Image Compression</b>	Need for image compression, Redundancy in images, Image-compression scheme, Fundamentals of Information Theory, Run-length coding, Shannon-Fano coding, Huffman Coding, Arithmetic Coding, Transform-based compression, Image-compression standard	

**Learning Resources recommended:****Textbook(s):**

- 1) Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 3rd Edition, Pearson, 2010.

**Additional Reference(s):**

- 1) Artificial Intelligence: Foundations of Computational Agents, David L Poole, Alan K. Mackworth, 2nd Edition, Cambridge University Press, 2017.
- 2) Artificial Intelligence, Kevin Knight and Elaine Rich, 3rd Edition, 2017 The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani and Jerome Friedman, Springer, 2013

**Evaluation Pattern****A . Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b>	20
<ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	
<b>Assignment/ Case study/ Presentations</b>	10
<ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation: 60 marks (Paper Pattern) Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

**Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24**

Name of the Course	<b>Digital Image Processing</b>
Course Code (refer to student handbook)	<b>USCSP602</b>
Class	TYBSc
Semester	VI
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:**

**Lecture/ week : 3**

<b>Practical need to be performed using Scilab under Linux or Windows. Minimum 8 practical to be implemented as a journal work.</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
1.	2D Linear Convolution, Circular Convolution between two 2D matrices.
2.	Circular Convolution expressed as linear convolution plus alias.
3.	Linear Cross correlation of a 2D matrix, Circular correlation between two signals and Linear autocorrelation of a 2D matrix, Linear Cross correlation of a 2D matrix
4.	DFT of 4x4 gray scale image.
5.	Compute discrete cosine transform, Program to perform KL transform for the given 2D matrix.
6.	Brightness enhancement of an image, Contrast Manipulation, image negative.
7.	Perform threshold operation, perform gray level slicing without background.
8.	Image Segmentation.
9.	Image Compression.
10.	Binary Image Processing and Colour Image processing.

**Evaluation Pattern**

**A) Internal Examination: 20 Marks**

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B) Semester End Examination: 30 Marks**

**Duration: 1 hrs**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Data Science</b>
Course Code (refer to student handbook)	<b>USCS606</b>
Class	TYBSc
Semester	VI
No of Credits	3
Nature	Theory
Type (applicable to NEP only)	---
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---

**Nomenclature: Data Science**

**Course Outcomes:** After completion of this course, the students should be able to understand & comprehend the problem; and should be able to define suitable statistical method to be adopted.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Introduction to Data Science</b>	What is Data? Different kinds of data, Introduction to high level programming language + Integrated Development Environment (IDE), Exploratory Data Analysis (EDA) + Data Visualization, Different types of data sources,	<b>15</b>
	<b>Data Management</b>	Data Collection, Data cleaning/extraction, Data analysis & Modeling	
<b>II</b>	<b>Data Curation</b>	Query languages and Operations to specify and transform data, Structured/schema based systems as users and acquirers of data Semi-structured systems as users and acquirers of data, Unstructured systems in the acquisition and structuring of data, Security and ethical considerations in relation to authenticating and authorizing access to data on remote systems, Software development tools, Large scale data systems, Amazon Web Services (AWS)	<b>15</b>
<b>III</b>	<b>Statistical Modelling and Machine Learning:</b>	Introduction to model selection: Regularization, bias/variance tradeoff e.g. parsimony, AIC, BIC, Cross validation, Ridge regressions and penalized regression e.g. LASSO	<b>15</b>
	<b>Data transformations :</b>	Dimension reduction, Feature extraction, Smoothing and aggregating	
	<b>Supervised Learning:</b>	Regression, linear models, Regression trees, Time-series Analysis, Forecasting, Classification: classification trees, Logistic regression, separating hyperplanes, k-NN	
	<b>Unsupervised Learning:</b>	Principal Components Analysis (PCA), k-means clustering, Hierarchical clustering, Ensemble methods	

**Learning Resources recommended:****Textbook(s):**

- 1) Doing Data Science, Rachel Schutt and Cathy O'Neil, O'Reilly,2013
- 2) Mastering Machine Learning with R, Cory Lesmeister, PACKT Publication,2015

**Additional Reference(s):**

- 1) Hands-On Programming with R, Garrett Golemund,1<sup>st</sup> Edition, 2014  
An Introduction to Statistical Learning, James, G., Witten, D., Hastie, T., Tibshirani, R.,Springer,2015

**Evaluation Pattern****A . Internal Evaluation: 40 marks**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>● It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>● The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>● Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B . Semester End Evaluation: 60 marks (Paper Pattern) Duration: 2 hrs**

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15



## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Data Science</b>
Course Code (refer to student handbook)	<b>USCSP602</b>
Class	TYBSc
Semester	VI
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:****Lecture/ week : 3**

<b>Practical shall be performed using R Minimum 8 practical to be implemented as a journal work.</b>	
<b>Sr. No.</b>	<b>Practical Title</b>
1.	Practical of Data collection, Data curation and management for Unstructured data (NoSQL)
2.	Practical of Data collection, Data curation and management for Large-scale Data system (such as MongoDB)
3.	Practical of Principal Component Analysis
4.	Practical of Clustering
5.	Practical of Time-series forecasting
6.	Practical of Simple/Multiple Linear Regression
7.	Practical of Logistics Regression
8.	Practical of Hypothesis testing
9.	Practical of Analysis of Variance
10.	Practical of Decision Tree

**A) Internal Examination: 20 Marks**

<b>Sr No</b>	<b>Criterion</b>	<b>Marks</b>
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

**B) Semester End Examination: 30 Marks**

**Duration: 1 hrs**

<b>Sr No</b>	<b>Criterion</b>	<b>Marks</b>
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Ethical Hacking</b>
Course Code (refer to student handbook)	<b>USCS607</b>
Class	TYBSc
Semester	VI
No of Credits	3
Nature	Theory
Type (applicable to NEP only)	
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

**Nomenclature: Ethical Hacking****Course Outcomes:**

- Learner will know to identify security vulnerabilities and weaknesses in the target applications.
- They will also know to test and exploit systems using various tools and understand the impact of hacking in real time machines.

**Curriculum:**

Unit	Title	Learning Points	No of Lectures
<b>I</b>	<b>Information Security : Attacks and Vulnerabilities</b>	Asset, Access Control, CIA, Authentication, Authorization, Risk, Threat, Vulnerability, Attack, Attack Surface, Malware, Security-Functionality-Ease of Use Triangle	<b>15</b>
	<b>Introduction to information security</b>		
	<b>Types of malware</b>	Worms, viruses, Trojans, Spyware, Rootkits	
	<b>Types of vulnerabilities</b>	OWASP Top 10 : cross-site scripting (XSS), cross site request forgery (CSRF/XSRF), SQL injection, input parameter manipulation, broken authentication, sensitive information disclosure, XML External Entities, Broken access control, Security Misconfiguration, Using components with known vulnerabilities, Insufficient Logging and monitoring, OWASP Mobile Top 10, CVE Database	
	<b>Types of attacks and their common prevention mechanisms</b>	Keystroke Logging, Denial of Service (DoS /DDoS), Waterhole attack, brute force, phishing and fake WAP, Eavesdropping, Man-in-the-middle, Session Hijacking, Clickjacking, Cookie Theft, URL Obfuscation, buffer overflow, DNS poisoning, ARP poisoning, Identity Theft, IoT Attacks, BOTs and BOTNETs	
	<b>Case-studies</b>	Recent attacks – Yahoo, Adult Friend Finder, eBay, Equifax, WannaCry , Target Stores, Uber, JP Morgan	

		Chase, Bad Rabbit	
<b>II</b>	<b>Ethical Hacking – I (Introduction and pre-attack)</b>	Black Hat vs. Gray Hat vs. White Hat (Ethical) hacking, Why is Ethical hacking needed?, How is Ethical hacking different from security auditing and digital forensics?, Signing NDA, Compliance and Regulatory concerns, Black box vs. White box vs. Black box, Vulnerability assessment and Penetration Testing.	<b>15</b>
	<b>Approach : Planning</b>	Threat Modeling, set up security verification standards, Set up security testing plan – When, which systems/apps, understanding functionality, black/gray/white, authenticated vs. unauthenticated, internal vs. external PT, Information gathering, Perform Manual and automated (Tools: WebInspect/Qualys, Nessus, Proxies, Metasploit) VA and PT, How WebInspect/Qualys tools work: Crawling/Spidering, requests forging, pattern matching to known vulnerability database and Analyzing results, Preparing report, Fixing security gaps following the report	
	<b>Enterprise strategy</b>	Repeated PT, approval by security testing team, Continuous Application Security Testing, <b>Phases:</b> Reconnaissance/foot-printing/Enumeration, <b>Phases:</b> Scanning, Sniffing	
<b>III</b>	<b>Phases : Gaining and Maintaining Access :</b>	<b>Phases : Gaining and Maintaining Access : Systems hacking – Windows and Linux – Metasploit and Kali Linux, Keylogging, Buffer Overflows, Privilege Escalation, Network hacking - ARP Poisoning, Password Cracking, WEP Vulnerabilities, MAC Spoofing, MAC Flooding, IPspoofing, SYN Flooding, Smurf attack, Applications hacking : SMTP/Email-based attacks, VOIP vulnerabilities, Directory traversal, Input Manipulation, Brute force attack, Unsecured login mechanisms, SQL injection, XSS, Mobile apps security, Malware analysis : Netcat Trojan, wrapping definition, reverse engineering Phases : Covering your tracks : Steganography, Event Logs alteration Additional Security Mechanisms : IDS/IPS, Honeypots and evasion techniques, Secure Code Reviews (Fortify tool, OWASP Secure Coding Guidelines)</b>	<b>15</b>

**Learning Resources recommended:****Textbook(s):**

- 1) Certified Ethical Hacker Study Guide v9, Sean-Philip Oriyano, Sybex; Study Guide Edition,2016
- 2) CEH official Certified Ethical Hacking Review Guide, Wiley India Edition, 2007
- 3) Certified Ethical Hacker: Michael Gregg, Pearson Education,1<sup>st</sup> Edition, 2013
- 4) Certified Ethical Hacker: Matt Walker, TMH,2011
- 5) [http://www.pentest-standard.org/index.php/PTES\\_Technical\\_Guidelines](http://www.pentest-standard.org/index.php/PTES_Technical_Guidelines)
- 6) [https://www.owasp.org/index.php/Category:OWASP\\_Top\\_Ten\\_2017\\_Project](https://www.owasp.org/index.php/Category:OWASP_Top_Ten_2017_Project)
- 7) [https://www.owasp.org/index.php/Mobile\\_Top\\_10\\_2016-Top\\_10](https://www.owasp.org/index.php/Mobile_Top_10_2016-Top_10)

- 8) [https://www.owasp.org/index.php/OWASP\\_Testing\\_Guide\\_v4\\_Table\\_of\\_Contents](https://www.owasp.org/index.php/OWASP_Testing_Guide_v4_Table_of_Contents)
- 9) [https://www.owasp.org/index.php/OWASP\\_Secure\\_Coding\\_Practices\\_-\\_Quick\\_Reference\\_Guide](https://www.owasp.org/index.php/OWASP_Secure_Coding_Practices_-_Quick_Reference_Guide)
- 10) <https://cve.mitre.org/>
- 11) <https://access.redhat.com/blogs/766093/posts/2914051>
- 12) <http://resources.infosecinstitute.com/applications-threat-modeling/#gref>  
<http://www.vulnerabilityassessment.co.uk/Penetration%20Test.html>

### Evaluation Pattern

#### A . Internal Evaluation: 40 marks

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>● It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>● The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>● Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

#### B. Semester End Evaluation: 60 marks (Paper Pattern) Duration: 2 hrs

Question No	Unit	Options	Marks
Q1	Unit 1	Any 3 out of 6	15
Q2	Unit 2	Any 3 out of 6	15
Q3	Unit 3	Any 3 out of 6	15
Q4	Unit 1,2,3	Objective Based	15

## Syllabus for T.Y.B.Sc. Computer Science Implementation Year 2023-24

Name of the Course	<b>Ethical Hacking</b>
Course Code (refer to student handbook)	<b>USCSP604</b>
Class	TYBSc
Semester	VI
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	—
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	—

**Curriculum:****Lecture/ week : 3**

*Practical shall be performed using CrypTool , Ubuntu , NMap scanner , XAMP server , Wireshark , Cain and Abel , python.*  
**Minimum 8 practical to be implemented as a journal work.**

Sr. No.	Practical Title
1.	Use Google and Whois for Reconnaissance.
2.	Use CrypTool to encrypt and decrypt passwords using RC4 algorithm.
3.	Run and analyze the output of following commands in Linux – ifconfig, ping, netstat, traceroute.
4.	Use NMap scanner to perform port scanning of various forms – ACK, SYN, FIN, NULL, XMAS.
5.	Simulate persistent cross-site scripting attack.
6.	Use Wireshark (Sniffer) to capture network traffic and analyze.
7.	Use Cain and Abel for cracking Windows account password using Dictionary attack and to decode wireless network passwords.
8.	Perform ARP Poisoning in Windows.
9.	Use Nemesy to launch DoS attack.
10.	Perform SQL injection attack.
11.	Create a simple keylogger using python.

**Learning Resources recommended:****Textbook(s):**

- 1) Certified Ethical Hacker Study Guide v9, Sean-Philip Oriyano, Sybex; Study Guide Edition, 2016
- 2) CEH official Certified Ethical Hacking Review Guide, Wiley India Edition, 2007

**Additional Reference(s):**

- 1) Certified Ethical Hacker: Michael Gregg, Pearson Education, 1<sup>st</sup> Edition, 2013
- 2) Certified Ethical Hacker: Matt Walker, TMH, 2011
- 3) [http://www.pentest-standard.org/index.php/PTES\\_Technical\\_Guidelines](http://www.pentest-standard.org/index.php/PTES_Technical_Guidelines)
- 4) [https://www.owasp.org/index.php/Category:OWASP\\_Top\\_Ten\\_2017\\_Project](https://www.owasp.org/index.php/Category:OWASP_Top_Ten_2017_Project)

- 5) [https://www.owasp.org/index.php/Mobile\\_Top\\_10\\_2016-Top\\_10](https://www.owasp.org/index.php/Mobile_Top_10_2016-Top_10)
- 6) [https://www.owasp.org/index.php/OWASP\\_Testing\\_Guide\\_v4\\_Table\\_of\\_Contents](https://www.owasp.org/index.php/OWASP_Testing_Guide_v4_Table_of_Contents)
- 7) [https://www.owasp.org/index.php/OWASP\\_Secure\\_Coding\\_Practices\\_-\\_Quick\\_Reference\\_Guide](https://www.owasp.org/index.php/OWASP_Secure_Coding_Practices_-_Quick_Reference_Guide)
- 8) <https://cve.mitre.org/>
- 9) <https://access.redhat.com/blogs/766093/posts/2914051>
- 10) <http://resources.infosecinstitute.com/applications-threat-modeling/#gref>
- 11) <http://www.vulnerabilityassessment.co.uk/Penetration%20Test.html>

### Evaluation Pattern

#### A) Internal Examination: 20 Marks

Sr No	Criterion	Marks
1	Journals containing minimum 8 practical's which are timely completed with desired output	10
2	Attendance & Practical Performance	10

#### B) Semester End Examination: 30 Marks

**Duration: 1 hrs**

Sr No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question	25
2	Viva	05

## II. Project(USCSP603)

The evaluation of the project will include a viva voce, which will assess the project based on the following parameters:

- **Documentation – 10 Marks:** The completeness, accuracy, and professionalism of the project documentation, including the project report and supporting materials, will be considered.
- **Quality of the Project – 10 Marks:** The overall quality of the project, including its design, implementation, and user experience, will be evaluated.
- **Working of the Project – 10 Marks:** The functionality and performance of the project will be assessed to determine how well it meets the specified requirements and objectives.
- **Project Presentation – 10 Marks:** The clarity, organization, and effectiveness of the project presentation will be evaluated.
- **Viva – 10 Marks:** The viva voce session will provide an opportunity for the student to demonstrate their knowledge and understanding of the project, as well as to answer questions and engage in a discussion with the evaluators.

### Project Guidelines

#### Aim:

The Project Work as part of B.Sc. Computer Science program provides students with practical experience in applying their knowledge and skills to real-world projects, emphasizing hands-on experience in industry- standard project practices. It focuses on project development, implementation, and deployment using computer science principles and techniques. Students will work individually or in teams to design, develop, and present a substantial software project, gaining exposure to real-life project scenarios. It also covers project planning, requirements gathering, software design, coding, testing, debugging, documentation, and project management, following industry best practices. Through these projects, students will enhance their problem-solving abilities, gain proficiency in software development methodologies, and strengthen their practical skills in computer science.

#### Objectives:

- Apply interdisciplinary knowledge to effectively solve real-life problems using acquired skills and concepts.
- Gain hands-on experience in the software development life cycle, encompassing requirements analysis, design, implementation, testing, and deployment.
- Familiarize with global IT industry standards, ethics, and professional practices to thrive in a professional environment.
- Develop teamwork and project management skills through structured collaboration, effective communication, and task delegation.
- Produce professional technical documentation aligning with industry practices, ensuring clarity, accuracy, and usability.
- Acquire time management, resource allocation, and personnel coordination skills for efficient project execution.

#### Project Types:

- Developing a solution for a real-life problem:** In this case, the project focuses on addressing an existing requirement for a computer-based solution that has practical applications. The project should successfully implement the different stages of the system development life cycle. Examples: Secure Online Banking System, Machine Learning-based Disease Diagnosis System, Cloud-based Document Management System.
- Innovative Product Development:** These projects involve exploring and developing a computer- based solution with a unique and innovative utility. Examples: Cybersecurity Monitoring and Threat Detection System, Machine Learning-powered Predictive



Maintenance System for Industrial Equipment, IoT-based Smart Energy Management System.

- c) **Research-Level Project:** These projects involve conducting research and development to explore advanced technologies and solve complex problems. Examples: Deep Learning-based Image Recognition System for Medical Imaging, Cloud Computing Infrastructure Optimization for Big Data Processing, Data Science-driven Predictive Analytics for Sales Forecasting. The methodology and reporting of such projects may vary based on the project supervisor's guidance.

### **Tools & Technologies:**

In the project work, students are granted complete freedom to select platforms, tools, and programming languages without any imposed restrictions. This approach encourages creativity, flexibility, and exploration of various technologies. By prioritizing open-source technologies, students can leverage a vast array of resources and community support. Commonly employed tools include IDEs, version control systems (e.g., Git), programming languages (e.g., Python, Java), databases (e.g., MySQL), and web frameworks (e.g., Django, Ruby on Rails). The evaluation process focuses on the project's content and implementation rather than the specific tools chosen, ensuring a fair assessment of the students' skills and problem-solving abilities.

### **Project Guide:**

Assigning a project guide to each project or group is a mandatory requirement to ensure the successful completion of the project work. The guide plays a crucial role as a mentor and technical expert, providing invaluable support and guidance to students. They are expected to facilitate effective communication and teamwork, review project proposals, assign schedules, and monitor progress on a regular basis. Additionally, guides are expected to offer timely feedback, provide guidance on project planning and implementation strategies, evaluate the quality of work, and promote professionalism and ethical conduct. Their expertise and involvement are essential in helping students navigate challenges, make informed decisions, and achieve their project goals effectively.

**Project Team Size:** 1 member

**Project Proposal:** The project proposal is a mandatory document that serves as a foundation for the project. It helps students define their project idea, receive early evaluation and feedback, establish clear communication with the project guide, and take ownership of the project's successful execution. A formal proposal ensures systematic and professional project planning, fostering critical thinking, effective communication, and project management skills. The proposal provides a roadmap and increases the chances of a successful outcome. Before initiating a project, it is mandatory to submit a project proposal for approval. **The original duly approved project proposal should be attached to the final project report.** The project proposal for UG computer science projects should include the following contents:

- Title
- Introduction
- Objectives: Clearly state the objectives of the project. What specific goals do you aim to achieve?
- Scope
- Methodology
- Tools and Technologies
- Timeline
- Resources
- Expected Outcomes
- References

**Project Report:**

The Certified Copy of Hard Bound Project Report must adhere to the following guidelines:

- No of Copies: Team Size + 1 (College / Department Copy)
- The project report should include the following
  - Title Page (*Sample attached in Appendix*)
  - Certificate (*Sample attached in Appendix*)
  - Table of Contents
  - Acknowledgement
  - Original Copy of approved Project Proposal
  - Self-attested copy of Plagiarism Report from any open source tool.
  - Chapters / Sections depending upon the type of project
  - List of Tables and/or List of Figures
  - References (IEEE / Springer format)
- Use of LaTeX for documentation purposes should be preferred.
- The text of the report should be set in 12 pt, Times New Roman font, and single-spaced.
- Chapter headings should be centered, written in 20 pt, Times New Roman font, bold, and in all caps.
- These guidelines ensure a standardized format for the project report, promoting clarity and readability.

# Appendix

## SAMPLE TITLE PAGE FORMAT

**A PROJECT REPORT**

on

**<PROJECT NAME>**

**In partial fulfillment of**

**B.Sc. in Computer Science**

*By*

**Mr. XYZ**

*Through*

***Gogate Jogalekar College  
(Autonomous),  
Ratnagiri***

**In**

**Sem V / VI October / March 202- – 202-**

**SAMPLE CERTIFICATE FORMAT**

<<College Name>> ,

**Department of Computer Science**

<<College Logo>>

**CERTIFICATE**

This is to certify that Mr./Ms. \_\_\_\_\_ of **T.Y.B.Sc. (Sem V/VI)** class bearing examination seat no. \_\_\_\_\_ has satisfactorily carried out Project on \_\_\_\_\_, as laid by the Board of Studies of Computer Science for the year **202-** . Hi boanafied work was completed under the guidance of Mr./Mrs. XYZ.

**Signature of Guide**

**Examiner**

**Head  
Department Computer Science**

**Date:**

**Place:**

The Chairperson,  
BoS of Computer Science

Affiliated to  
University of Mumbai



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

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

Four Semesters

**Course: Computer Science**

**Syllabus for MSc Semester I & II**

Under Choice Based Credit System (CBCS)

To be implemented from Academic  
Year- 2023-2024

## **Preamble**

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

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

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

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

Name of Programme	<b>Masters of Science</b>
Level	PG
No of Semesters	04
Year of Implementation	<b>2023-24</b>
Programme Specific Outcomes (PSO)	<p>At the end of the Programme, Learner will be able to</p> <ol style="list-style-type: none"> <li>1. Develop a solid foundation in fundamental concepts, theories, and methodologies of Computer Science.</li> <li>2. Offer opportunities for specialization in a chosen area of Computer Science.</li> <li>3. Foster a research-oriented mindset and contribute to the advancement of Computer Science.</li> <li>4. Prepare learners for lifelong learning, adapting to emerging technologies and industry requirements.</li> <li>5. Inculcate professional attitudes, leadership qualities, and social responsibility.</li> <li>6. Equip students with industry-relevant skills and experiences for successful careers.</li> <li>7. Enhance critical thinking and innovative problem-solving abilities.</li> </ol>
Relevance of PSOs to the local, regional, national, and global developmental needs	<ol style="list-style-type: none"> <li>1. <b>Provide In-depth Knowledge:</b> The program aims to provide students with a comprehensive understanding of the key concepts, theories, and methodologies in Computer Science. It covers a range of topics including machine learning, data mining, data visualization, and data management, enabling students to develop a deep knowledge base in these areas.</li> <li>2. <b>Develop Programming Skills:</b> The program aims to equip students with strong programming skills by providing hands-on experience with different tools and technologies. Students will gain proficiency in designing front-end and back-end solutions, enhancing their ability to develop robust and scalable applications.</li> <li>3. <b>Foster Problem-solving Abilities:</b> The program aims to enhance students' problem-solving abilities by training them to approach real-world data challenges critically and creatively. Students will learn to identify problems, design appropriate data analysis strategies, and develop innovative solutions using their knowledge of Computer Science.</li> <li>4. <b>Encourage Collaboration and Teamwork:</b> The program aims to foster collaboration and teamwork skills among students, recognizing that computer science projects often require interdisciplinary collaboration. Students will learn to effectively</li> </ol>



	<p>communicate, collaborate, and contribute as part of a team, preparing them for collaborative work environments.</p> <ol style="list-style-type: none"><li>5. <b>Foster Industry Relevance:</b> The program aims to stay up-to-date with industry trends and technologies to ensure graduates are well-prepared for the demands of the Computer Science job market. Through industry partnerships and internships, students will have the opportunity to gain practical experience and stay in touch with the latest advancements in the field.</li><li>6. <b>Professional Development:</b> The program aims to prepare students for successful careers in the field of Computer Science. In addition to technical skills, students will develop professional skills such as teamwork, project management, and leadership. The program may also provide networking opportunities, internships, or collaborations with industry partners to enhance students' industry readiness and employability.</li><li>7. <b>Cultivate Research Skills:</b> The program aims to cultivate research skills among students by providing a Research Methodology Course and encouraging participation in research projects. Students will learn to conduct literature reviews, design experiments, analyze data, and present their findings, fostering a research-oriented mindset and contributing to the advancement of Computer Science.</li></ol>
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### EVALUATION

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

A) Internal Assessment: 40 % (40 Marks )

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

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

**Duration:** The examination shall be of 2 hours' duration.

Question Paper Pattern

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

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

**Standard of Passing**

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

**Performance Grading:****Letter Grades and Grade Points**

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

**SMART Criteria for Course Outcomes:**

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

**Measurable:** Each outcome can be measured through assessments, tests, mini-projects and projects to determine the level of understanding and proficiency achieved by the students.

**Achievable:** The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

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

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

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

**M.Sc. I**  
(To be implemented from Academic Year 2023-24)

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

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

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

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

**Applied Signal and Image Processing****Modules at glance**

<b>Sr . No .</b>	<b>Module s</b>	<b>No. of Lectures</b>
1	Fundamentals of Digital Signals Processing	15
2	Image Processing fundamentals and Pixel-Transformation	15
3	Structural and Morphological Operations	15
4	Advanced Image Processing Operations	15
<b>Total</b>		<b>60</b>

**Course Outcomes:**

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

1. Understand and apply the fundamentals of digital signal processing and frequency domain operations for image analysis.
2. Gain proficiency in image processing techniques such as intensity transformations, histogram processing, and smoothing.
3. Develop skills in edge detection and image segmentation using various algorithms and approaches.
4. Utilize morphological operations for image enhancement, feature extraction, and noise reduction.
5. Apply advanced image processing techniques including feature detection, descriptors, and segmentation algorithms for complex image analysis and understanding.

**Curriculum:**

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

**Learning Resources recommended:**

**A] Books and Textbooks:**

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



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

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

**Course Outcomes:**

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

**Curriculum:**

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

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

### Learning Resources recommended:

#### A) Books and Textbooks:

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

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

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

## Software Defined Networking

### *Modules at a Glance*

Sr . No .	Module s	No. of Lectures
1	Introduction to Computer Networking	15
2	Software Defined Networking	15
3	Network Functions Virtualization	15
4	Design and implementation of Network	15
<b>Total</b>		<b>60</b>

### Course Outcomes:

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

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

**Curriculum:**

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

**Learning Resources recommended:****A] Books and Textbooks:**

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

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

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

**Course Outcomes:**

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

**Curriculum:**

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

**Learning Resources recommended:**

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



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

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

*Modules at a Glance*

<b>Sr. No.</b>	<b>Modules</b>	<b>No. of Lectures</b>
1.	Front end of Compiler	15
2.	Back end of Compiler	15
<b>Total</b>		<b>60</b>

**Course Outcomes:**

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

- Understand the theoretical foundations and concepts underlying the design and implementation of compilers.
- Acquire knowledge about the different phases of the compilation process
- Learn how to design and implement lexical analyzers and parsers
- Gain hands-on experience in building semantic analyzers
- Understand intermediate code generation and Implement optimization techniques
- Gain practical experience in code generation
- Familiarity with runtime environments and Develop skills in error handling and debugging
- Explore advanced topics in compiler design and Apply knowledge to practical projects.

**Curriculum:**

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

**Learning Resources Recommended:****A] Books and Textbooks:**

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

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

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

**NoSQL Technologies*****Modules at a Glance***

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

**Course Outcomes:****At the end of the Course, the Learner will be able to**

- Understand NoSQL characteristics, storage types, and advantages/drawbacks.
- Interface and interact with MongoDB, Redis, HBase, and Apache Cassandra effectively.
- Comprehend storage architecture in NoSQL, including column-oriented, document stores, and key/value stores.
- Perform CRUD operations proficiently, including data creation, access, update, and deletion.
- Query NoSQL stores using MongoDB features, accessing HBase data, and querying Redis.
- Apply indexing and ordering concepts in NoSQL databases like MongoDB, CouchDB, and Cassandra.
- Manage transactions and ensure data integrity in NoSQL, including distributed ACID systems.
- Utilize NoSQL effectively in the cloud, such as Google App Engine Data Store and Amazon SimpleDB.

## Curriculum:

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

**Learning Resources recommended:****A] Books and Textbooks:**

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

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

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

**Course Outcomes:**

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

**Curriculum:**

Course Code	Course Title	Credits
PSCSP106	NoSQL Technologies Practical	02
<b>Note :</b> -Practical's should be implemented using MongoDB, Redis and Hbase Minimum 8 Practicals should be submitted as Journal Work.		
1	<b>Lab Exercise: Setting up and Exploring MongoDB</b> <ol style="list-style-type: none"> <li>Install MongoDB on your local machine or lab server.</li> <li>Create a new MongoDB database and collection.</li> <li>Insert sample data into the collection.</li> <li>Retrieve and display data from the collection using MongoDB queries.</li> </ol>	

2	<p><b>Interacting with Redis</b></p> <ol style="list-style-type: none"> <li>Install Redis on your lab server or local machine.</li> <li>Store and retrieve data in Redis using various data structures like strings, lists, and sets.</li> <li>Implement basic Redis commands for data manipulation and retrieval</li> </ol>
3	<p><b>Working with HBase</b></p> <ol style="list-style-type: none"> <li>Set up an HBase cluster in a lab environment.</li> <li>Create an HBase table and define column families.</li> <li>Insert sample data into the table.</li> <li>Perform CRUD operations and retrieval of data in HBase.</li> </ol>
4	<p><b>Apache Cassandra Operations</b></p> <ol style="list-style-type: none"> <li>Install and configure Apache Cassandra in a lab environment.</li> <li>Create a keyspace and define a table schema.</li> <li>Insert data into the table.</li> <li>Perform CRUD operations and query data from Apache Cassandra.</li> </ol>
5	<p><b>Querying MongoDB and HBase</b></p> <ol style="list-style-type: none"> <li>Write and execute MongoDB queries to retrieve specific data from a collection.</li> <li>Perform queries on HBase tables using HBase shell commands.</li> </ol>
6	<p><b>Redis Data Manipulation</b></p> <ol style="list-style-type: none"> <li>Use Redis commands to manipulate and modify data stored in different data structures.</li> <li>Retrieve specific data using Redis query operations.</li> </ol>
7	<p><b>Implementing Indexing in MongoDB</b></p> <ol style="list-style-type: none"> <li>Create an index on a specific field in a MongoDB collection.</li> <li>Measure the impact of indexing on query performance.</li> </ol>
8	<p><b>Data Storage in Redis</b></p> <ol style="list-style-type: none"> <li>Implement caching functionality using Redis as a cache store.</li> <li>Store and retrieve data from Redis cache using appropriate commands.</li> </ol>
9	<p><b>Using Google App Engine Data Store</b></p> <ol style="list-style-type: none"> <li>Create a project in Google App Engine and set up the Data Store.</li> <li>Store and retrieve data from the Data Store using the provided API.</li> </ol>
10	<p><b>Amazon SimpleDB Data Management</b></p> <ol style="list-style-type: none"> <li>Task 1: Set up an Amazon SimpleDB domain for data storage.</li> <li>Task 2: Store and retrieve data from the SimpleDB domain using appropriate commands or APIs.</li> </ol>



**Learning Resources recommended:**

**A] Books and Textbooks:**

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

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

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

## Robotics

### *Modules at a Glance*

Sr. No.	Modules	No. of Lectures
1	Introduction to Robotics	15
2	Servo Motors	15
<b>Total</b>		<b>30</b>

#### Course Outcomes:

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

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

#### Curriculum:

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

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

**A] Books and Textbooks:**

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

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

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

**Nomenclature:** Robotics Practical

**Course Outcomes:**

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

**Curriculum:**

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

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

**Learning Resources recommended:**

**A] Books and Textbooks:**

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

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

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

**UI/UX Design***Modules at a Glance*

<b>Sr. No.</b>	<b>Modules</b>	<b>No. of Lectures</b>
1.	Introduction to UI	15
2.	Introduction to UX	15
<b>Total</b>		<b>30</b>

**Course Outcomes:**

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

- To Understand Latest UI patterns
- Understand iterative user-centered design of graphical user interfaces
- Apply the user Interfaces to different devices and requirements,
- Create high quality professional documents and artifacts related to the design process

Curriculum:

<b>Sr. No.</b>	<b>Modules / Units</b>
1	Introduction to UI (15 Hours)
	What is User Interface Design (UI): The Relationship Between UI and UX, Roles in UI/UX, A Brief Historical Overview of Interface Design, Interface Conventions, Approaches to Screen Based UI, Template vs Content, Formal Elements of Interface Design, Active Elements of Interface Design, Composing the Elements of Interface Design, UI Design Process, Visual Communication design component in Interface Design
2	Introduction to UX (15 Hours)
	UX Basics: Foundation of UX design, Good and poor design, Understanding Your Users, Designing the Experience Elements of user Experience, Visual Design Principles, Functional Layout, Interaction design, Introduction to the Interface, Navigation Design, User Testing, Developing and Releasing Your Design Design Tools: Interviews, writing personas: user and device personas, User Context,



	Building Low Fidelity Wireframe and High-Fidelity Polished Wireframe Using wireframing Tools, Creating the working Prototype using Prototyping tools, Sharing and Exporting Design
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**Learning Resources Recommended:**

**A] Books and Textbooks:**

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

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

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

**Course Outcomes:**

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

**Curriculum:**

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

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

### **Learning Resources Recommended:**

#### **A] Books and Textbooks:**

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

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

Name of the Course	Research Methodology
Course Code	PSCS109
Class	M.Sc.
Semester	I
No of Credits	4
Nature	Theory
Type	Research Methodology
Highlight revision specific to employability/ entrepreneurship/ skill development	Learner will gain the knowledge of Research Methodology in Business application. Further, the learner will be benefited in the form of increase in his research aptitude, analytical and decision-making skills. Acquisition of the knowledge in the field of research will increase the chances of employability and will offer better prospects in the corporate sector.

**Research Methodology***Modules at a Glance*

Sr. No.	Modules	No. of Lectures
1	Fundamentals of Research Methods	15
2	Research Design and Measurement Concepts and Literature Searching	15
3	Documentation, scientific writing and Academic Integrity	15
4	Research Testing	15
<b>Total</b>		<b>60</b>

**Course Outcomes:**

- Understand fundamentals of research methods
- Learn design and measurement concepts of research
- Know data collection and analysis tools
- Get knowledge of scientific report writing

**Curriculum:**

Sr. No.	Modules / Units
1	Fundamentals of Research Methods (15 Hours)
	Definition of research, Role and objectives of research, importance of research, Applications and types of research, Creativity and innovation, Critical thinking, Research process and steps in it, Collecting and reviewing the literature, Conceptualization and Formulation of: research problem, identifying variables, constructing hypothesis and Synopsis. Interpretation of results and discussion.
2	Research Design and Measurement Concepts and Literature Searching (15 Hours)
	Selecting and defining a research problem, Need for research design, Features of a good research design, Different research designs, Scales of measurements, Nominal, Ordinal, Internal and ratio scales, Errors in measurements, Validity and Reliability in measurement, Scale Construction Techniques. Digital: Web sources, E-journals, Journal access, Citation Index, Impact factor, H-index, E-consortium, UGC info net, eBooks, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar,, Scopus

3	Documentation, scientific writing and Academic Integrity (15 Hours)
	<p>Documentation and scientific writing: Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography. for illustration, style, publications of scientific work,</p> <p>Research and Academic Integrity: Intellectual property rights (IPRs). Plagiarism, Copyright issues, Ethics in research, and case studies.</p>
4	Research Testing(15 Hours)
	<p>Statistical analysis and fitting of data : Introduction to Statistics – Probability Theories - Conditional Probability, Poisson Distribution, Binomial Distribution and Properties of Normal Distributions, Estimates of Means and Proportions; Chi-Square Test, Association of Attributes - t-Test –Anova- Standard deviation - Co-efficient of variations. Co-relation and Regression Analysis.</p> <p>Implementation of Mathematical and statistical analysis using software tools like MAT Lab, SPSS, PsiLAB or free ware tools.</p>

### Learning Resources recommended:

#### A) Books and Textbooks:

1. . Kothari C.R., –Research Methodology, Methods and Techniques|| (Second revised edition, New Age International Publication, 2004).
2. Saravanavel P., –Research Methodology|| (Kitab Mahal, Sixteenth edition, 2007).
3. Ranjit Kumar, –Research Methodology, a step-by-step guide for beginners|| (Pearson education Australia, Second edition 2005).
4. Mark Saunders, Philip Lewis, Adrain Thornhiu, –Research Methods for Business Students|| (Pearson Education ltd, Seventh edition, 2016)

#### B) Academic Journals and Publications:

1. Thesis & Assignment Writing–J Anderson, B.H.Dursten & M.Poole, Wiley Eastern, 1977

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

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

**M.Sc. II**

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



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

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

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

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

**Nomenclature:** Machine Learning

**Course Outcomes:**

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

- Develop a solid understanding of the fundamentals of machine learning, including its types and applications.
- Apply various machine learning techniques such as linear regression, logistic regression, and decision trees to train models and make predictions.
- Gain proficiency in using support vector machines (SVM) for classification and regression tasks.
- Explore the fundamentals of deep learning and artificial neural networks, including their architecture and activation functions.
- Acquire practical skills in implementing machine learning algorithms using the TensorFlow framework and analyzing performance measures for model evaluation

## Curriculum:

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

**Learning Resources recommended:****A] Books and Textbooks:**

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

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

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

**Nomenclature:** Machine Learning Practical

**Course Outcomes:**

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

**Curriculum:**

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

Syllabus for First Year PG Computer Science; implementation year 2023-24

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

**Learning Resources recommended:**

**A] Books and Textbooks:**

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

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

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

*Modules at a Glance*  
**Natural Language Processing**

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

**Course Outcomes:**

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

- Understanding the importance and concepts of Natural Language Processing (NLP)
- Applying algorithms available for the processing of linguistic information and computational properties of natural languages.
- Knowledge on various morphological, syntactic, and semantic NLP tasks.
- Introducing various NLP software libraries and data sets publicly available.

**Curriculum:**

Sr. No.	Modules / Units
1	Introduction to Natural Language Processing (NLP) and Language Modelling (15 Hours)
	Introduction to NLP: Introduction and applications, NLP phases, Difficulty of NLP including ambiguity; Spelling error and Noisy Channel Model; Concepts of Parts- of speech and Formal Grammar of English. Language Modelling: N-gram and Neural Language Models Language Modelling with N-gram, Simple N-gram models, smoothing (basic techniques), Evaluating language models; Neural Network basics, Training; Neural Language Model, Case study: application of neural language model in NLP system development Python Libraries for NLP: Using Python libraries/packages such as Natural Language Toolkit (NLTK), spaCy, genism

2	Morphology & Parsing in NLP (15 Hours)
	Computational morphology & Parts-of-speech Tagging: basic concepts; Tagset; Lemmatization, Early approaches: Rule-based and TBL; POS tagging using HMM, Introduction to POS Tagging using Neural Model. Parsing Basic concepts: top-down and bottom-up parsing, treebank; Syntactic parsing: CKY parsing; Statistical Parsing basics: Probabilistic Context-Free Grammar (PCFG); Probabilistic CKY Parsing of PCFGs.
3	Semantics and Word Embedding (15 Hours)
	Semantics Vector Semantics: Words and Vector; Measuring Similarity; Semantics with dense vectors; SVD and Latent Semantic Analysis Embeddings from prediction: Skip-gram and Continuous Bag of words; Concept of Word Sense; Introduction to WordNet
4	NLP Applications and Case Studies (15 Hours)
	Intelligent Work Processors: Machine Translation; User Interfaces; man-machine Interfaces: Natural language Querying Tutoring and Authoring Systems. Speech Recognition Commercial use of NLP: NLP in customer Service, Sentiment Analysis, Emotion Mining, Handling Frauds and SMS, Bots, LSTM & BERT models, Conversations

Learning Resources recommended:

**[A] Books and Textbooks:**

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



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

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

**Nomenclature:** Natural Language Processing Practical

**Course Outcomes:**

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

**Curriculum:**

Course Code	Course Title	Credits
PSCSP514	Natural Language Processing Practical	02
<b>Note:</b> - The following set of Practical can be performed using any Python Libraries for NLP such as NLTK, spaCy, genism: Link:- <a href="https://www.python.org/downloads/">https://www.python.org/downloads/</a> Minimum 8 Practicals should be Submitted as Journal Work.		
1	Write a program to implement sentence segmentation and word tokenization	
2	Write a program to Implement stemming and lemmatization	
3	Write a program to Implement a tri-gram model	
4	Write a program to Implement PoS tagging using HMM & Neural Model	
5	Write a program to Implement syntactic parsing of a given text	
6	Write a program to Implement dependency parsing of a given text	
7	Write a program to Implement Named Entity Recognition (NER)	
8	Write a program to Implement Text Summarization for the given sample text	
	<b>CASE STUDIES</b>	
9	Consider a scenario of applying NLP in Customer Service. Design and develop an application that demonstrates NLP operations for working with tasks and data like voice calls, chats, Ticket Data, Email Data. Process the data to understand the voice of the Customer (intent mining, Top words, word cloud, classify topics). Identify issues, replace patterns and gain insight into sales chats.	
10	Consider a scenario of Online Review and demonstrate the concept of sentiment analysis and emotion mining by applying various approaches like lexicon-based approach and rule-based approaches.	
11	Apply NLP in Banking, Financial Services, and Insurance. Design Application to detect frauds and work with SMS data	
12	Demonstrate the use of NLP in designing Virtual Assistants. Apply LSTM, build conversational Bots	

**Learning Resources recommended:****[A] Books and Textbooks:**

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

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

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

**Simulation and Modelling***Modules at a Glance*

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

**Course Outcomes:**

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

- To introduce students to the fundamental concepts and components of computer simulation and modeling.
- To provide students with a comprehensive understanding of statistical models commonly used in simulation studies.
- To familiarize students with different queueing models and their characteristics for analyzing system performance.
- To develop students' skills in generating random numbers and random variates for simulation experiments.
- To equip students with the knowledge and techniques for input modeling and selecting appropriate input models for simulations.

**Curriculum:**

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

**Learning Resources Recommended:**

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

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

***with Effect from the Academic Year 2023-2024***

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

**Bioinformatics***Modules at a Glance*

Sr. No.	Modules	No. of Lectures
1.	Biological Data Analysis	15
2.	Computational Tools and Methods	15
<b>Total</b>		<b>30</b>

## Course Outcomes:

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

- Gain a solid understanding of fundamental concepts and principles in bioinformatics, including sequence analysis, genome analysis, protein structure prediction, and gene expression analysis
- Acquire the ability to analyze and interpret biological data, such as DNA or protein sequences, microarray data, or next-generation sequencing data
- Learn statistical methods and techniques for extracting meaningful insights from large datasets.
- Develop skills in using bioinformatics tools and software packages commonly used in the field, such as BLAST, EMBOSS and Biopython
- Awareness of Ethical and Legal Considerations
- Develop the ability to stay updated with the latest advancements and emerging trends in bioinformatics research and technologies

## Curriculum:

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

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

**Learning Resources recommended:****A] Books and Textbooks:**

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



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

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

**Nomenclature:** Bioinformatics Practical

**Course Outcomes:**

1. Gain a solid understanding of fundamental concepts and principles in bioinformatics, including sequence analysis, genome analysis, protein structure prediction, and gene expression analysis
2. Acquire the ability to analyze and interpret biological data, such as DNA or protein sequences, microarray data, or next-generation sequencing data
3. Learn statistical methods and techniques for extracting meaningful insights from large datasets.
4. Develop skills in using bioinformatics tools and software packages commonly used in the field, such as BLAST, EMBOSS and Biopython
5. Awareness of Ethical and Legal Considerations
6. Develop the ability to stay updated with the latest advancements and emerging trends in bioinformatics research and technologies

**Curriculum:**

<b>Course Code</b>	<b>Course Title</b>	<b>Credits</b>
<b>PSCSP206</b>	<b>Bioinformatics Practical</b>	<b>02</b>
<b>Note:</b> Software and Tools : Python. <b>Minimum 8 Practicals should be Submitted as Journal Work.</b>		
1	Sequence Manipulation <ul style="list-style-type: none"> <li>Read and parse sequence data from files</li> <li>Perform basic sequence manipulations (e.g., reverse complement, translation)</li> </ul>	
2	Sequence Alignment <ul style="list-style-type: none"> <li>Perform pairwise sequence alignment using algorithms like Needleman-Wunsch or Smith-Waterman</li> <li>Implement multiple sequence alignment using methods such as ClustalW or MUSCLE</li> </ul>	
3	Database Searching <ul style="list-style-type: none"> <li>Perform sequence searches against databases (e.g., BLAST or FASTA)</li> <li>Retrieve and analyze search results</li> </ul>	
4	Protein Structure Analysis <ul style="list-style-type: none"> <li>Retrieve protein structures from databases like PDB</li> <li>Calculate structural properties (e.g., secondary structure, solvent accessibility)</li> <li>Perform structure visualization and analysis</li> </ul>	
5	Genomic Data Analysis <ul style="list-style-type: none"> <li>Retrieve genomic data from databases (e.g., NCBI)</li> <li>Analyze gene annotations, promoter regions, or regulatory elements</li> <li>Perform genomic variant analysis</li> </ul>	
6	Data Preprocessing <ul style="list-style-type: none"> <li>Cleaning and preprocessing biological data (e.g., gene expression data, DNA sequences)</li> <li>Handling missing values, outliers, and normalization of data</li> <li>Feature selection and dimensionality reduction techniques</li> </ul>	
7	Classification <ul style="list-style-type: none"> <li>Applying machine learning algorithms (e.g., decision trees, random forests, support vector machines) to classify biological samples or sequences</li> <li>Evaluating model performance using metrics such as accuracy, precision, recall, and F1-score</li> </ul>	
8	Regression <ul style="list-style-type: none"> <li>Building regression models to predict quantitative biological properties (e.g., protein structure, gene expression levels)</li> <li>Assessing model performance using metrics such as mean squared error or R-squared</li> </ul>	
9	Clustering <ul style="list-style-type: none"> <li>Applying clustering algorithms (e.g., k-means, hierarchical clustering) to group similar biological samples or sequences</li> <li>Assessing clustering quality using metrics such as silhouette coefficient or</li> </ul>	

	Rand index
10	<p>Visualizing clusters and analyzing their biological significance</p> <ul style="list-style-type: none"> <li>● Data Visualization:</li> <li>● Generate plots, graphs, and figures to visualize bioinformatics results</li> <li>● Use libraries like Matplotlib, Seaborn, or ggplot in Python or R for visualization</li> <li>● Create interactive visualizations using tools like D3.js or Plotly</li> </ul>

Learning Resources recommended:

**A] Books and Textbooks:**

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

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

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

**Embedded and IoT Technology***Modules at a Glance*

<b>Sr. No.</b>	<b>Modules</b>	<b>No. of Lectures</b>
1	Embedded System Basics	15
2	Advanced IOT Technologies	15
<b>Total</b>		<b>30</b>

**Course Outcomes:**

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

- Understand embedded systems design and basics of IoT components.
- Learn about electronics and microcontrollers in embedded systems.
- Gain knowledge of IoT building blocks, sensors, and wireless sensor networks.
- Explore advanced IoT technologies, including gateway architecture and cloud computing.
- Understand IoT security, communication, and design connected IoT systems using Packet Tracer

**Curriculum:**

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

**Learning Resources recommended:****A] Books and Textbooks:**

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

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

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

**Nomenclature:** Embedded and IoT Technology Practical

**Course Outcomes:**

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

**Curriculum:**

Course Code	Course Title	Credits
PSCSP207	Embedded and IoT Technology Practical	02
<p><b>Note:</b> - The following set of practicals should be implemented in CodeVisionAVR, Proteus8, Cisco Packet Tracer, Keli V5, Python</p> <p><b>Link:</b> -            Python:<a href="https://www.python.org/downloads/">https://www.python.org/downloads/</a>            CodeVisionAVR :<a href="https://www.codevision.be/">https://www.codevision.be/</a>            Proteus8:<a href="https://www.labcenter.com/downloads/">https://www.labcenter.com/downloads/</a>            Cisco Packet Tracer:<a href="https://www.netacad.com/courses/packet-tracer">https://www.netacad.com/courses/packet-tracer</a>            Keli V5: <a href="https://www.keil.com/download/">https://www.keil.com/download/</a></p> <p><b>Minimum 8 Practical should be Submitted as Journal Work.</b></p>		
1	Design and implement basics embedded circuits 1. Automatic Alarm system- Alarm should get trigger by sensor 2. Timer based buzzer 3. Sensor based Counting device	
2	Demonstrate communication between two embedded devices using UART port	
3	Built an IoT system to send ticket before entering the bus.	
4	Demonstrate an IoT based game which can be played between two player who are physically at a considerable distance.	
5	Develop a IoT application which will record the movement and orientation of your phone and give the data back to the PC	
6	Develop an IoT application that will raise an alarm whenever with going to rain outside based on the weather prediction data.	
7	Deploy an IoT application which will alert you by beeping or vibrating your phone whenever you get someone call your name.	
8	Develop an IoT application for monitoring water levels in tanks and automatically start the motor to fill the tank if the level goes below the critical level.	
9	Develop an IoT module to which measure the intensity of light and send the same to your PC/ Phone	
10	Develop an IoT application for Motion detection.	

**Learning Resources recommended:**

## A] Books and Textbooks:

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



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

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

**Web Data Analytics***Modules at a Glance*

Sr . No .	Module s	No. of Lectures
3.	Introduction to Web Mining	15
4.	Social Network & Link Analysis	15
<b>Total</b>		<b>30</b>

**Course Outcomes:**

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

- Understand the concepts and techniques of web mining, including sequential pattern mining and rule generation.
- Gain knowledge of information retrieval models, text preprocessing, and web search techniques.
- Learn about opinion mining and sentiment classification in web information retrieval.
- Explore social network analysis, link analysis, and the implementation of webpage crawlers.
- Understand web usage mining, including the discovery and analysis of web usage patterns, and the use of recommender systems and query log mining

## Curriculum:

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

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

**A] Books and Textbooks:**

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

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

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

**Nomenclature:** Web Data Analytics Practical**Course Outcomes:**

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

**Curriculum:**

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

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

### **Learning Resources Recommended:**

#### **A] Books and Textbooks:**

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

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

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

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

**Introduction:**

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

**Guidelines for On Job Training**

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

**Course Objectives:**

By the end of the course, students should be able to:

1. Gain exposure to real-world insights and apply theoretical knowledge to practical situations
2. Enhance his skills regarding problem-solving, decision-making, and communication skills.
3. Understand organizational dynamics and work culture.
4. Build industry connections and networking opportunities

**Course Duration:**

Minimum 20 days / 100 hours of On Job Training with an Organization/ NGO/ Charitable Organization/ Private firm.

- The theme of the internship should be based on any study area of the Major course
- Project Report should be of minimum 50 pages
- Experience Certificate is Mandatory

**Report Structure:**

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

**a) Title Page:**

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

**b) Certificate of Completion:**

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

**c) Declaration:**

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

**d) Acknowledgments:**

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

**e) Table of Contents:**

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

**f) Executive Summary:**

A bird's eye view of your entire presentation has to be precisely offered under this Category.

**g) Introduction on the Company:**

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

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

The key aspects handled, the department under which you were deployed and brief Summary report duly acknowledged by the reporting head.

**i) Challenges:**

The challenges confronted while churning out theoretical knowledge into practical world.

**j) Conclusion:**

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

**Course Outcomes:**

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

**Rubrics for Field Project Report Evaluation:**

1. Content (40 Points)

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



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

## 2. Presentation (20 points):

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

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

### 3. Research Methodology (10 points):

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

### 4. Creativity and Innovation (10 points):

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

### 5. Overall Impression (10 points):

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

**Conclusion:**

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

**a) Title Page:**

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

**b) Certificate of Completion:**

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

**c) Declaration:**

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

**d) Acknowledgments:**

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

**e) Table of Contents:**

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

**f) Executive Summary:**

A bird's eye view of your entire presentation has to be precisely offered under this Category. A brief overview of the project, its objectives, and key findings should be mentioned

**g) Introduction:**

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

**h) Literature Review:**

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

**i) Methodology:**

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

**j) Field Visits and Observations:**

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

**k) Data Analysis:**

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

**i) Understanding Policies and Programmes:**

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

**ii) Identified Socio-Economic Problems:**

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

**l) Innovative Solutions:**

Presentation of innovative practices proposed to address the identified problems.

Description of the action plans to implement these solutions

**m) Conclusion & Recommendations:**

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

**n) References & Appendices:**

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

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

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

Format

1 st page (Main Page)

**Title of the problem of the Project**

A Project Submitted

to

**R. P. Gogate college of Arts & Science and**

**R.V. Jogalekar College of Commerce Autonomous College**

under

**University of Mumbai**

for partial completion of the degree

of

**Master in Science**

**in special Group Computer Science**

Under the Faculty of Science

By

Name of Student

Under the Guidance of

Name of the Guiding Teacher

**R. P. Gogate college of Arts & Science and**

**R.V. Jogalekar College of Commerce Autonomous College,**

Near District Court

Month and Year

On separate page  
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05		

The Chairperson,  
BoS of Computer Science

Affiliated to  
University of Mumbai



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

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

**Course: Computer Science**

**Syllabus for MSc Semester III & IV**

Under Choice Based Credit System (CBCS)

To be implemented from Academic  
Year- 2023-2024



### **Preamble**

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

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

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

The Four Elective in semester- III is mentioned below:

- Advanced Computing
- Security
- Computer Networking
- Data Science

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

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

Name of Programme	<b>M Sc Computer Science</b>
Level	PG
No of Semesters	04
Year of Implementation	<b>2023</b>
Programme Specific Outcomes (PSO)	<ol style="list-style-type: none"> <li>1. To be fundamentally strong at core subject of Computer Science.</li> <li>2. To apply programming and computational skills for industrial solutions.</li> <li>3. Broad understanding of latest technological trends.</li> <li>4. To identify opportunities for establishing an enterprise for immediate Employment.</li> <li>5. Able to understand and apply fundamental research concepts.</li> <li>6. Able to use efficient soft skills for professional development.</li> <li>7. Engage in independent and life-long learning for continued professional development.</li> </ol>
Relevance of PSOs to the local, regional, national, and global developmental needs (200 words)	<ol style="list-style-type: none"> <li>1. <b>Provide In-depth Knowledge:</b> The program aims to provide students with a comprehensive understanding of the key concepts, theories, and methodologies in Computer Science. It covers a range of topics including machine learning, data mining, data visualization, and data management, enabling students to develop a deep knowledge base in these areas.</li> <li>2. <b>Develop Programming Skills:</b> The program aims to equip students with strong programming skills by providing hands-on experience with different tools and technologies. Students will gain proficiency in designing front-end and back-end solutions, enhancing their ability to develop robust and scalable applications.</li> <li>3. <b>Foster Problem-solving Abilities:</b> The program aims to enhance students' problem-solving abilities by training them to approach real-world data challenges critically and creatively. Students will learn to identify problems, design appropriate data analysis strategies, and develop innovative solutions using their knowledge of Computer Science.</li> <li>4. <b>Encourage Collaboration and Teamwork:</b> The program aims to foster collaboration and teamwork skills among</li> </ol>

	<p>students, recognizing that computer science projects often require interdisciplinary collaboration. Students will learn to effectively communicate, collaborate, and contribute as part of a team, preparing them for collaborative work environments.</p> <ol style="list-style-type: none"><li>5. <b>Foster Industry Relevance:</b> The program aims to stay up-to-date with industry trends and technologies to ensure graduates are well-prepared for the demands of the Computer Science job market. Through industry partnerships and internships, students will have the opportunity to gain practical experience and stay in touch with the latest advancements in the field.</li><li>6. <b>Professional Development:</b> The program aims to prepare students for successful careers in the field of Computer Science. In addition to technical skills, students will develop professional skills such as teamwork, project management, and leadership. The program may also provide networking opportunities, internships, or collaborations with industry partners to enhance students' industry readiness and employability.</li><li>7. <b>Cultivate Research Skills:</b> The program aims to cultivate research skills among students by providing a Research Methodology Course and encouraging participation in research projects. Students will learn to conduct literature reviews, design experiments, analyze data, and present their findings, fostering a research-oriented mindset and contributing to the advancement of Computer Science.</li></ol>
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## EVALUATION

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

### A) Internal Assessment: 40 % (40 Marks)

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

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

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

#### Question Paper Pattern

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

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

**STANDARD OF PASSING**

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

**Performance Grading:****Letter Grades and Grade Points**

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

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

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

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

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

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

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

**SMART Criteria for Course Outcomes:**

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

**Measurable:** Each outcome can be measured through assessments, tests, or projects to determine the level of understanding and proficiency achieved by the students.

**Achievable:** The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

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

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

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

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

Nomenclature: **Advanced Computing (Web3 Technology)**

**Course Outcomes:**

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



**Curriculum:**

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

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

**TEXTBOOKS:**

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

**REFERENCE BOOKS:**

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

**Evaluation Pattern****A. Internal Evaluation:**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation (Paper Pattern)**

Duration: 2Hours

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

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

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

**Course Outcomes:**

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

**Curriculum:**

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

### Evaluation Pattern

#### A. Internal Evaluation : 20 Marks

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

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

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

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

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

**Course Outcomes:**

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

**Curriculum:**

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



**Learning Resources recommended:****TEXTBOOKS:**

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

**Evaluation Pattern****A. Internal Evaluation:**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation (Paper Pattern)**

Duration: 2Hours

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

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

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

**Course Outcomes:**

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

**Curriculum:**

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

**Learning Resources recommended:****TEXTBOOKS:**

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

**Evaluation Pattern**

**A. Internal Evaluation : 20 Marks**

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

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

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

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

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

**Course Outcomes:**

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

**Curriculum:**

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

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

**Learning Resources recommended:**

**TEXTBOOKS:**

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

**REFERENCE BOOKS:**

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

**Evaluation Pattern****A. Internal Evaluation:**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation (Paper Pattern)**

Duration: 2Hours

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



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

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

**Course Outcomes:**

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

**Curriculum:**

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

### Evaluation Pattern

#### A. Internal Evaluation : 20 Marks

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

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

Sr. No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question Duration: 2 Hours	25
2	Viva	05

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

**Nomenclature: Security (Cyber Security and Risk Assessment)**

**Course Outcomes:**

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

**Curriculum:**

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

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

**Learning Resources recommended:**

**TEXTBOOKS:**

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

**Evaluation Pattern****A. Internal Evaluation:**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation (Paper Pattern)**

Duration: 2Hours

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

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

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

**Course Outcomes:**

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



**Curriculum:**

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

**Evaluation Pattern**

**A. Internal Evaluation : 20 Marks**

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

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

<b>Sr. No</b>	<b>Criterion</b>	<b>Marks</b>
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question Duration: 2 Hours	25
2	Viva	05

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

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

**Course Outcomes:**

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

**Curriculum:**

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

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

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

**REFERENCE BOOKS:**

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

**Evaluation Pattern****A. Internal Evaluation:**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation (Paper Pattern)**

Duration: 2Hours

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

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

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

**Course Outcomes:**

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

**Curriculum:**

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

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

### Evaluation Pattern

#### A. Internal Evaluation : 20 Marks

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

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

Sr. No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question Duration: 2 Hours	25
2	Viva	05



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

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

**Course Outcomes:**

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

**Curriculum:**

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

**Learning Resources recommended:**

**TEXTBOOK:**

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

**REFERENCE BOOKS:**

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

**Evaluation Pattern**

**A. Internal Evaluation:**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation (Paper Pattern)**

Duration: 2Hours

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

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

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

**Course Outcomes:**

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

**Curriculum:**

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

**Teaching plan:**

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

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

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

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

Sr. No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question Duration: 2 Hours	25
2	Viva	05

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

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

**Course Outcomes:**

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

**Curriculum:**

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

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

**Learning Resources recommended:****TEXTBOOKS:**

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

**REFERENCE BOOKS:**

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



**Evaluation Pattern****A. Internal Evaluation**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation (Paper Pattern)**

Duration: 2Hours 30Minutes

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

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

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

**Course Outcomes:**

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

**Curriculum:**

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

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

### Evaluation Pattern

#### A. Internal Evaluation : 20 Marks

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

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

Sr. No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question Duration: 2 Hours	25
2	Viva	05

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

**Nomenclature: Data Science (Big Data Analytics)**

**Course Outcomes:**

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

**Curriculum:**

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

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

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

**REFERENCE BOOKS:**

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

**Evaluation Pattern****A. Internal Evaluation:**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>• It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>• The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>• Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation (Paper Pattern)**

Duration: 2Hours

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

Q.5	Unit I, II, III & IV	<i>Objective Based</i>	12
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Name of the Course	<b>Practical Course on Elective-2: Data Science (Big Data Analytics)</b>
Course Code (refer to student handbook)	PSCSP3042
Class	M.Sc. Computer Science
Semester	III
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	-
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

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

**Course Outcomes:**

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

**Curriculum:**

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



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

### Evaluation Pattern

#### A. Internal Evaluation : 20 Marks

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

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

Sr. No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question Duration: 2 Hours	25
2	Viva	05

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

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

Nomenclature: **Robotics (Online Mode)**

**Course Outcomes:**

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

**Curriculum:**

<b>Unit</b>	<b>Title</b>	<b>Learning Points</b>	<b>No of Lectures</b>
UNIT 1	Introduction to Robotics	Introduction to Robotics: What is a robot? Examples of Advanced and impressive robots, Robots in the home, Robots in industry Robotics in Action: Exploring Robot Building Blocks - Code and Electronics Technical requirements, Introducing the Raspberry Pi - Starting with Raspbian Technical requirements, Raspberry Pi controller on a robot	15
UNIT 2	Building Robot Basics	Technical requirements: Robot chassis kit with wheels and motors, a motor controller, Powering the robot, Test fitting the robot, Assembling the base. Robot Programming: Programming technique, adding line sensors to our robot, creating line-sensing behavior, and Programming RGB Strips in robot	15
UNIT 3	Servo Motors	Use and control of servo motors, pan, and tilt mechanism. Distance sensors, Introduction to distance sensors and their usage Connecting distance sensors to robot and their testing. Creating a smart object avoidance behavior. Creating a menu to select different robot behaviors, Distance and speed measuring sensors—encoders and odometry	15
UNIT 4	Robot Vision and Voice Communication	Robotics setup: Setting up a Raspberry Pi Camera on the robot (software and hardware), Check the robot vision on a phone or laptop, Mask images with RGB strips	15

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

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

**REFERENCE BOOKS:**

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

**Evaluation Pattern****A. Internal Evaluation:**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation (Paper Pattern)**

Duration: 2Hours

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

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

**Nomenclature: Robotics (Online Mode)**

**Course Outcomes:**

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

**Curriculum:**

Course Code	Course Title	Credits
PSCSP401	Practical Course on Robotics (Online Mode)	02
<b>Note: Following practical can be performed using Python and simulators, Raspberry Pi, and other hardware devices.</b>		
<b>Minimum 8 Practicals need to be submitted as Journal work.</b>		
1	Making a Raspberry Pi headless, and reaching it from the network using WiFi and SSH.	
2	Using sftp upload files from PC.	
3	Write Python code to test motors.	
4	Write a script to follow a predetermined path.	
5	Develop Python code for testing the sensors.	
6	Add the sensors to the Robot object and develop the line-following behavior code.	
7	Using the light strip develop and debug the line follower robot.	
8	Add pan and tilt service to the robot object and test it.	
9	Create an obstacle avoidance behavior for robot and test it.	
10	Detect faces with Haar cascades.	
11	Use the robot to display its camera as a web app on a phone or desktop, and then use the camera to drive smart color and face-tracking behaviors.	
12	Use a Raspberry Pi to run the Mycroft environment and connect it to a speaker/microphone combination	

### Evaluation Pattern

#### A. Internal Evaluation : 20 Marks

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

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

Sr. No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question Duration: 2 Hours	25
2	Viva	05

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

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

**Course Outcomes:**

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



**Curriculum:**

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

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

**TEXTBOOKS:**

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

**REFERENCE BOOKS:**

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

**Evaluation Pattern****A. Internal Evaluation:**

Method	Marks
<b>Mid-Term Class Test</b> <ul style="list-style-type: none"> <li>It should be conducted using any <b>learning management system</b> such as <b>Moodle</b>(Modular object-oriented dynamic learning environment)</li> <li>The test should have <b>20 MCQ's</b> which should be solved in a time duration of <b>40 minutes</b>.</li> </ul>	20
<b>Assignment/ Case study/ Presentations</b> <ul style="list-style-type: none"> <li>Assignment / Case Study Report / Presentation can be uploaded on any <b>learning management system</b>.</li> </ul>	10
<b>Attendance</b>	05
<b>Behavior</b>	05

**B. Semester End Evaluation (Paper Pattern)**

Duration: 2Hours

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

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

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

**Course Outcomes:**

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

**Curriculum:**

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

### Evaluation Pattern

#### A. Internal Evaluation : 20 Marks

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

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

Sr. No	Criterion	Marks
1	One Practical Question <b>OR</b> Combination of Practical Questions <b>OR</b> Combination of Practical Question and Theory Question Duration: 2 Hours	25
2	Viva	05

Course Code	Course Title	Credits
PSCSP403	Internship with Industry	06

**Context:**

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

Internship details:

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

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

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

**Internship mentors:**

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

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

students and within the demand of the program.

### **Documentation of the internship:**

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

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

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

### **Interaction between mentors:**

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



**Internship workload for the faculty:**

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

Course Code	Course Title	Credits
PSCSP404	Project Implementation	06

#### **Guidelines for Project Implementation in Semester - IV**

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

#### **Guidelines for Documentation of Project Proposal in Semester –IV**

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

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

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

(Seal of the organization)

**Appendix-I**

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

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

Internship starting date: \_\_\_\_\_

Internship ending date: \_\_\_\_\_

Actual number of days worked: \_\_\_\_\_

Tentative number of hours worked: \_\_\_\_\_ Hours

Broad area of work: \_\_\_\_\_

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

\_\_\_\_\_  
\_\_\_\_\_

Signature: \_\_\_\_\_

Name: \_\_\_\_\_

Designation: \_\_\_\_\_

Contact number: \_\_\_\_\_

Email: \_\_\_\_\_

(Seal of the organization)

**Appendix-II**

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

**Professional Evaluation of intern**

Name of intern: \_\_\_\_\_ College/institution: \_\_\_\_\_

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

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

Comments: \_\_\_\_\_

Signature: \_\_\_\_\_ Name: \_\_\_\_\_

Designation: \_\_\_\_\_ Contact number: \_\_\_\_\_ Email: \_\_\_\_\_

(Seal of the organization)

**Appendix-III**

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

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

\_\_\_\_xxx\_\_\_\_

The Chairperson,  
BoS of Computer Science