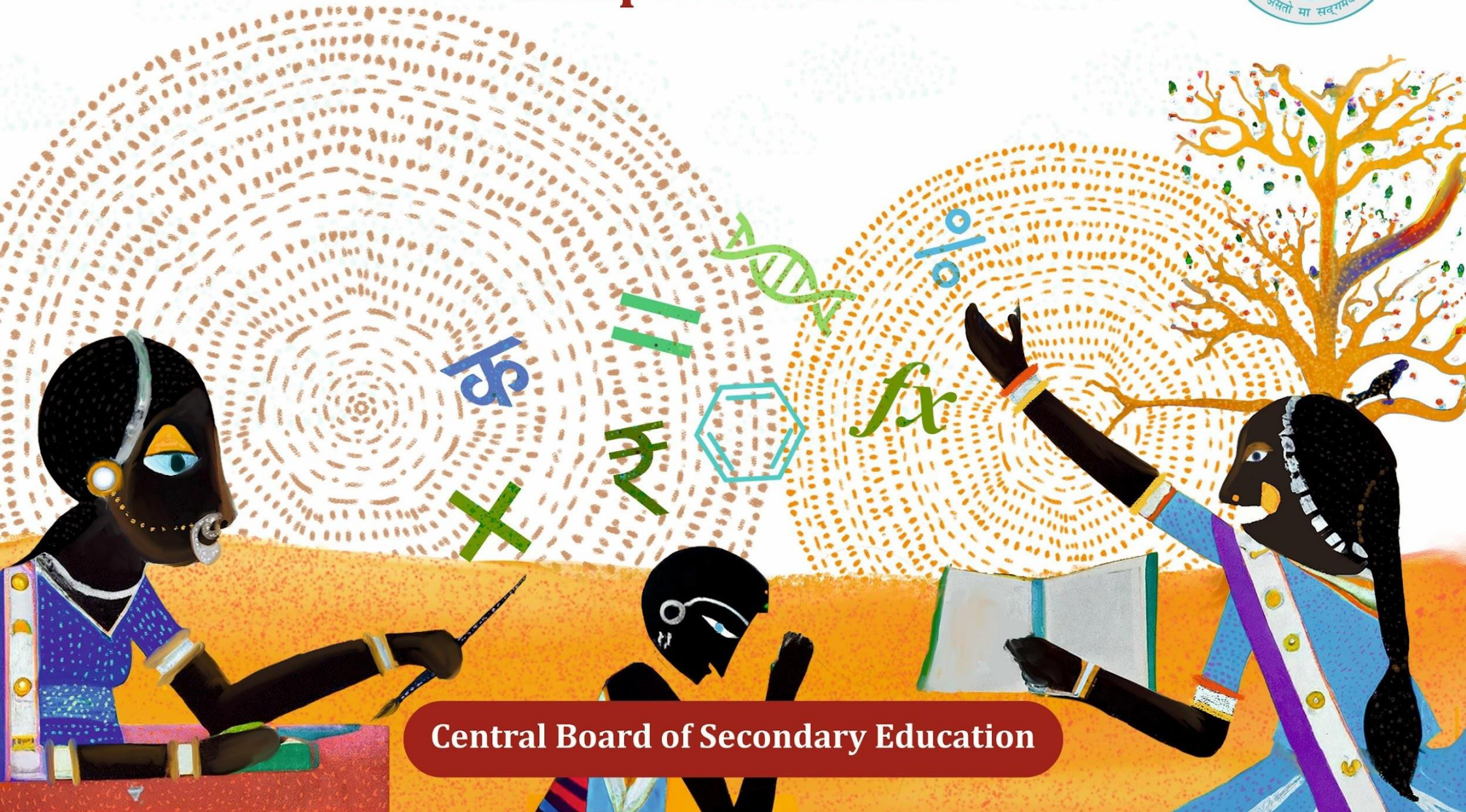
Learning Framework Classes 11-12
Computer Science



Central Board of Secondary Education

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Learning Framework Classes 11-12
Computer Science

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Co-created by
CBSE Centre for Excellence in Assessment
and
Educational Initiatives

1. FOREWORD

The vision of the National Education Policy (NEP) 2020 released by the Government of India, directs that children not only learn but more importantly learn how to learn. Education must move towards less content, and more towards learning about how to think critically and solve problems, how to be creative and multidisciplinary, and how to innovate, adapt, and absorb new material in novel and changing fields. Pedagogy must evolve to make education more experiential, holistic, integrated, inquiry-driven, discovery-oriented, learner-centred, discussion-based, flexible, and, of course, enjoyable. The policy has a clear mandate for competency-based education (CBE) to enhance the acquisition of critical 21st-century skills by learners. The first determinant for implementing CBE is a curriculum which is aligned with defined learning outcomes and that clearly states the indicators to be achieved.

The Central Board of Secondary Education (CBSE) has collaborated with Educational Initiatives, to develop the Learning Framework for English, Hindi, Mathematics, Physics, Chemistry, Biology, History, Geography, Economics, Accountancy, Business Studies and Computer Science in Grade 11 and 12. The Learning Frameworks comprise explicitly stated knowledge, skills and dispositions that an education system should try to achieve. These frameworks would help develop a common shared understanding among teachers, students and other stakeholders and would serve as a standard benchmark for teaching, learning and assessment across the country.

These frameworks present indicators that are aligned with the CBSE curriculum and the NCERT learning outcomes. They further outline samples of pedagogical processes and assessment strategies to encourage curiosity, objectivity, and creativity to nurture scientific temper. This framework would be a key resource for teachers executing the curriculum. They have been developed to ensure that teachers align the learning to meet the set quality standards and also use them to track the learning levels of students. The effort has been to synchronize focus on quality education with uniformity of standards across CBSE schools.

We hope these frameworks will not only become a reference point for competency-based education across the country but also facilitate the planning and design of teaching-learning processes and assessment strategies by teachers and other stakeholders.

Please note that the learning frameworks have been drafted based on the 2022-23 curriculum. Certain chapters and topics rationalized in the 2023-24 curriculum are retained in this document. In this learning framework, the content units and topics are based on the 2022-23 syllabus, even though there is no change in the rationalized syllabus of 2023-24.

Any feedback regarding the framework is welcomed.

Team CBSE

2. PREFACE

The National Education Policy 2020 has outlined the importance of competency-based education in classrooms, leading to curricular and pedagogical reforms in the school systems. The policy emphasizes the development of higher-order skills such as analysis, critical thinking and problem-solving through classroom instructions and aligned assessments. These skills are important indicators which will further the dissemination of pedagogy and learning outcomes across schools and boards.

To propagate indicator-based learning through 'Learning Frameworks', the Central Board of Secondary Education has collaborated with Educational Initiatives (Ei). Learning frameworks are a comprehensive package which provides learning outcomes, indicators, assessment frameworks, samples of pedagogical processes, tools and techniques for formative assessment, blueprints, assessment items and rubrics. 12 frameworks have been developed for English, Hindi, Mathematics, Physics, Chemistry, Biology, History, Geography, Economics, Accountancy, Business Studies and Computer Science in Grades 11 and 12.

The frameworks are adopted from the learning outcomes outlined in the NCERT which are mapped to key concepts of the content. These content domain-specific learning outcomes are broken down into indicators which define the specific skills a learner needs to attain. A clear understanding of these LOs will be immensely helpful for teachers and students to learn better.

In addition to this, make the most use of this framework.

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4. NATURE OF THE SUBJECT

Computer science as a discipline has evolved over the years and has emerged as a driving force of our socioeconomic activities. It has made continuous inroads into diverse areas — be it business, commerce, science, technology, sports, health, transportation or education.

The course aims to provide opportunities that will enable students to equip themselves with the practical and technical skills needed to function effectively in a technological society. It aims to develop a foundation of computer science knowledge to harness the power of computational thinking to enable students to become both users and creators of computing technology.

The focus of the course is to develop problem-solving abilities and technical skills as they learn how to diagnose and solve problems while understanding the fundamental concepts. It also opens a window to emerging trends and advances in computer science.

In this course, students also explore the ethical, moral and legal factors that influence developments in computing so that they recognise the consequences of decisions made by developers and users with respect to the development and use of technology.

5. STAGE-SPECIFIC CURRICULAR EXPECTATIONS

The aims describe the purposes of a course based on this syllabus.

The course emphasizes the need for both a theoretical and practical approach to building an understanding of the various methodologies used to solve problems in computer science. Use activities and reflection to generate interest and skills necessary for independent and lifelong learning.

The aims are to enable students to develop:

- a body of knowledge, methods and techniques that characterize computer science
- computational thinking skills
- skills required to use the body of knowledge, methods and techniques
- an understanding of the main principles of solving problems using computers
- logical and critical thinking to investigate, identify and resolve complex problems
- the skills necessary to solve computer-based problems using a high-level programming language
- an understanding of the components of computer systems and how they interrelate
- an understanding of the internet as a means of communication and its associated risks
- awareness of the moral, ethical, social, economic and environmental implications of using computer technology
- an appreciation of the possibilities and limitations associated with the advances and trends in the field of computer science

6. CONTENT DOMAINS

The content for computer science for grades 11-12 in the CBSE curriculum has been organized around major units. Units for the two grades, along with the chapters from the NCERT textbooks are mentioned in the tables below.

CLASS 11

Unit	Chapters
1. Computer Systems and Organisation	CH 1 Computer System
	CH 2 Encoding Schemes and Number System
	CH 3 Emerging Trends
2. Computational Thinking and Programming - 1	CH 4 Introduction to Problem Solving
	CH 5 Getting Started with Python
	CH 6 Flow of Control
	CH 7 Functions
	CH 8 Strings
	CH 9 Lists
	CH 10 Tuples and Dictionaries
3. Society, Law and Ethics	CH 11 Societal Impact

CLASS 12

Unit	Chapters
1. Computational Thinking and Programming - 2	CH 1 Exception Handling in Python
	CH 2 File Handling in Python
	CH 3 Stack
	CH 4 Queue
	CH 5 Sorting
	CH 6 Searching
2. Computer Networks	CH 10 Computer Networks
	CH 11 Data Communication
	CH 12 Security Aspects
3. Database Management	CH 7 Understanding Data
	CH 8 Database Concepts
	CH 9 Structured Query Language (SQL)

Note: Chapter 13: Project-based learning would be covered as part of project work included in the Practicals.

7. SUBJECT-SPECIFIC COGNITIVE DOMAINS

"As the Board is progressively allowing more space to 'learning outcome based' assessment in place of textbook driven assessment, question papers of Board examinations will have more questions based on real-life situations requiring students to apply, analyse, evaluate and synthesize information as per the stipulated outcomes. The core-competencies to be assessed in all questions, however, will be from the prescribed syllabus and textbooks recommended therein. This will eliminate predictability and rote learning to a large extent."

[CBSE Curriculum for classes 11-12]

The course in computer science prepares students to develop capability in critical and creative thinking as they imagine, generate, develop, produce and critically evaluate ideas by engaging in systems, design and computational thinking. It enables students to learn to make the most of the digital technologies available to them and prepares them to adapt to new ways of doing things as technologies evolve, and limits the risks to themselves and others in a digital environment. It allows students to appreciate the impact of technology on society and its influence on how we learn, communicate, commute or even socialise! It aims to develop their capacity to understand and apply ethical and socially responsible principles when creating and using technologies and tools. It also informs students of various study and work options and bridges the gap between school and work.

While the textbook introduces the fundamental concepts and problem-solving skills in computer science, every attempt must be made also to bring out the practical linkages of the course with real life. Students are expected to do projects both in classes 11 and 12, however, these should be treated as a minimum. Students should be encouraged to undertake individual and group activities that help them appreciate the practical applications of the course. In this manner, they will develop skills at all levels of the cognitive domain as indicated below.

CATEGORIES OF COGNITIVE DOMAINS

Revised Bloom's taxonomy (Anderson and Krathwohl, 2001) of cognitive process dimension has six categories, each associated with specific cognitive processes. CBSE curriculum intends to have a balance of these categories of intellectual tasks in the teaching-learning and assessment of learning of a subject. These six categories as described in the revised Bloom's taxonomy, with their specific cognitive processes, are mentioned below.

COGNITIVE DOMAIN – REMEMBER

'Remember' involves retrieving relevant knowledge from long-term memory. **Recognizing** and **recalling** are the specific cognitive skills associated with this cognitive domain. Asking students about foundational facts and concepts, *e.g. List 2 characteristics of Stacks, Which command will you use to view the list of tables in a database?*

COGNITIVE DOMAIN – UNDERSTAND

'Understand' involves 'constructing meaning from instructional messages, including oral, written and graphic communication'. **Interpreting**, **exemplifying**, **classifying**, **summarizing**, **inferring**, **comparing**, and **explaining** are the specific cognitive skills associated with this cognitive domain. Asking students to explain a process or a technique e.g. *Process of how data is transferred from CPU to memory; Explain why hexadecimal numbers are frequently used in computer programming; Describe one difference between stack and queue data structures, Describe the role of a router in a network etc.*

COGNITIVE DOMAIN – APPLY

'Apply' involves carrying out or using a procedure in a given situation. **Executing** and **implementing** are the specific cognitive skills associated with this cognitive domain. Assessment tasks wherein students have to use the knowledge and/or procedures to solve a problem or to arrive at a decision in a given real-life situation cover this cognitive domain. *e.g. Write an SQL query to generate a required output from a given table, Deduce the output of a given statement or code snippet, write an algorithm or a program in Python to complete a given task like – reversing a given string, find the highest 2 values in a dictionary.*

COGNITIVE DOMAIN – ANALYSE

'Analyse' involves breaking material into constituent parts and determining how parts relate to one another and an overall structure and purpose. **Differentiating**, **organising** and **attributing** are the specific cognitive skills associated with this cognitive domain. Asking students to analyze **computer concepts** on correctness, robustness, safety liveness etc. e.g. *Analysing the algorithm presented as a flow chart.*

COGNITIVE DOMAIN – EVALUATE

'Evaluate' involves making judgments based on criteria and standards. **Checking** and **critiquing** are the specific cognitive skills associated with this cognitive domain. Assessment tasks that require a deeper level of understanding wherein students are required to provide justification for their

choice, e.g. *Evaluate two algorithms to decide which one is more efficient, Evaluate a search algorithm to explain how a search algorithm will perform when the input grows larger.*

COGNITIVE DOMAIN – CREATE

'Create' involves combining elements to form a coherent or functional whole; or reorganizing elements into a new pattern or structure. **Generating**, **planning** and **producing** are the specific cognitive skills associated with this cognitive domain. Tasks that require students to produce new artefacts based on what they have learnt, e.g. *Create a project that is tangible and useful using Python file handling/ Python-SQL connectivity.*

KINDS OF ASSESSMENT TASKS FOR DIFFERENT COGNITIVE DOMAINS

Some more examples of kinds of assessment tasks that can be associated with the different cognitive domains are given below. A chapter may not always cover all six cognitive domains. The following list of tasks should be taken as an indicative list and not a comprehensive one.

Cognitive domain	Assessment tasks
Remember • Recognize • Recall	• Define the basic concepts in computer science like types of memory, functions of Boolean operators, types of networks • Define the basic number systems • List characteristics of basic elements like Stacks, queues, • Identify basic and core commands/concepts used commonly in programming like print, input, seek, tell etc [Note: Students are not expected to memorize all the syntax, but only the commonly used commands]. Eg: *Which function would you use to find out the current position of the file object?* *How would the Python program know where a for block ends?*
Understand • Interpret • Exemplify	• Explain concepts like encoding, the scope of variables, data encryption, and exception

• Classify • Summarize • Infer • Compare • Explain	• Justify the use of a process/data type or expression in an algorithm/code eg: Which data structure would be most suited for storing the list of students and their corresponding ranks. • Illustrate with examples the use of concepts like functions/ list operation/built-in libraries • Explain the concept of different emerging technologies like AI, robotics etc. • Explain programming concepts e.g.: How does binary search sort work? • Inferring about concepts in computer science programming *E.g.: Which of these statements about for and while loops in Python is TRUE?* ○ *A* for *loop usually runs a given number of times; a* while *loop runs till a condition is met.* ○ *Statements in a* for *loop are always run at least once; those in a* while *loop may never be run.* ○ *A* for *loop cannot contain another for loop; a* while *loop can contain another while loop.* ○ *A* for *loop always has to have a loop counter; a* while *loop never uses a loop counter* • Differentiating between different concepts. e.g.: What are the differences between stacks and queues? List the main difference between open-source and proprietary software. What is the difference between for and while loop?
Apply • Execute • Implement	• Construct an algorithm/code for a specified scenario using the conditions given • Decompose a given problem statement to sub-tasks and express the solution to a given problem as a sequence of defined steps. • Amend an algorithm or code to rectify the errors given.
Analyze • Differentiate • Organize	• Trace an algorithm/code to identify the errors in the program or code snippet and suggest changes to a code/algorithm to rectify and achieve the desired output. • Analyse the code and deduce the values of the variable(s) at different junctures of the program

• Attribute	• Examine the given code to replace parts of the code with reusable modules/functions to simplify the code. • Interpret the output of a given algorithm or dry run the code to verify where it is the required result. • Discuss the practical use-case of different emerging technologies like AI, and robotics
Evaluate • Check • Critique	• Critique the use of different emerging trends in different real-life situations. • Evaluate the algorithm and recommend changes to make it more efficient • Compare algorithms to choose the suitable one for a given scenario • Critique the given code and recommend modifications to improve the program. • Discuss the emerging trends in computer and information technology and critique how they influence modern society.
Create • Generate • Plan • Produce	• Create an algorithm/program that uses multiple CS concepts to solve a given problem. Like creating a program that helps manage your spending like check balance, and storing your income and expenditure. • Design projects like a system to scan the commodities and print the bill for purchases at a grocery store depending upon the price and quantity of an item.

8. LEARNING OUTCOMES FOR COMPUTER SCIENCE SENIOR SECONDARY STAGE

Following learning outcomes for the senior secondary stage developed by CBSE state important knowledge, skills and dispositions students need to attain at the end of an academic year in classes 11 and 12 in the context of learning chemistry.

CLASS 11

Unit	CBSE Learning Outcome	
1 Computer Systems and Organisation	1	Develop a basic understanding of computer systems - architecture, and operating systems.
	2	Develop a basic understanding of various encoding schemes and number systems along with their applications in digital technology.
	3	Develop a basic understanding of new technologies in Information technology and how are they affecting the modern lifestyle
2 Computational Thinking and Programming	4	Appreciate the notion of the algorithm including flowcharts and pseudocode.
	5	Explain and use operators, variables and data types including higher-order data structures such as lists, strings, tuples, and dictionaries.
	6	Develop basic principles of computational thinking[1].
3 Society, Law and Ethics	7	Explain cyber ethics, cyber safety and cybercrime
	8	Understand the value of technology in societies along with consideration of gender and disability issues

[1] Computational thinking refers to the thought processes involved in expressing solutions as computational steps or algorithms that can be carried out by a computer – from Lee, I. (2016). Reclaiming the roots of CT. *CSTA Voice: The Voice of K–12 Computer Science Education and Its Educators*, *12*(1), 3–4.

CLASS 12

Unit	CBSE Learning Outcome	
1 Computational Thinking and Programming	1	Apply the concept of function.
	2	Implement search and sort techniques.
	3	Create and use Python libraries
	4	Explain and use the concept of exception as well as file handling.
	5	Explain the concept of efficiency in algorithms and computing in general
	6	Use basic data structure: Stacks and Queues.
2 Computer Networks	7	Explain computer networks and how it works.
	8	Explain the security concerns in networked computers and methods to mitigate them
3 Database Management	9	Use Database concepts, SQL to store, retrieve and manipulate data

9. APPROACHES TO THE TEACHING AND LEARNING OF COMPUTER SCIENCE

CBSE class 11 and 12 computer science (CS) course is offered as an optional subject at the higher secondary stage. Students usually opt for CS intending to pursue a career in software development or related areas, after going through professional courses at higher levels. The primary focus of this course is on introducing the basic concepts of computer science and fostering the development of computational thinking and problem-solving skills. Teachers must familiarize themselves with this approach before they commence teaching.

It is expected that teachers use a wide range of activities to support the theoretical content that enables students to develop as learners, users, and creators of computer science knowledge and solutions.

FOSTERING COMPUTATIONAL THINKING

The Australian Curriculum defines computational thinking as "*A problem-solving method that involves various techniques and strategies that can be implemented by digital systems. Techniques and strategies may include organising data logically, breaking down problems into parts, defining abstract concepts and designing and using algorithms, patterns and models.*"

Computational thinking is a problem-solving methodology that we draw from when thinking about how a computer can help us to solve complex problems and create solutions. It is an analytical skill that has its foundation in the concepts from computer science but is a fundamental skill that can be used to solve complex problems in almost all other fields.

Some of the key concepts in computational thinking are:

- Decomposition
- Pattern Recognition
- Abstraction
- Algorithm Design

Decomposition is breaking down complex problems into smaller, more manageable chunks. Decomposition allows students to assess the problem at hand and figure out all of the steps needed to make the task happen and break down the task into small simple steps. Pattern recognition is simply looking for patterns in the problem and determining how they could be leveraged to solve the problem at hand. While abstraction helps in identifying crucial information from a problem and ignoring the details that are not relevant. And finally lay down the solution as a sequence of steps with appropriate rules to achieve the desired result.

DELIVERING THE COURSE

At the level of classes 11 and 12, developing the ability to logically solve problems irrespective of the programming language is crucial. At this stage, a deep knowledge of programming languages is not the main concern. Hence the focus needs to be on computational thinking. For this purpose, the course is based on Python which is not syntax heavy.

Unlike other courses, the syllabus is written in a prescriptive manner and follows a textbook. The textbook provides a reliable source of information for students who do not have access to other resources. However, teachers are encouraged to share appropriate resources from websites, blogs, videos, online courses, and books as references. Teachers are encouraged to give enough hands-on opportunities to decompose a system, gaining an understanding of algorithms that influence the way it functions. These should also include real-world problems that are relevant and contemporary.

The natural learning progression in the course should be along a path that progresses from understanding the basics to more sophisticated knowledge in a subject area. Hence the learning progressions should deliberately revisit a concept across multiple units with evolving sophistication. For example, the learning progression for creating a modular algorithm would start with the simple understanding of constructing algorithms for simple tasks and then progress to problems in which tasks need to be broken down into smaller tasks and finally evolve to a stage where students learn that programs can be composed of parts of other programs.

While the objective of digital technologies teaching is to develop higher-order thinking skills and enough opportunities should be there to allow students to experiment with algorithmic development, and a range of computational thinking skills, it should be ensured that the principles of the foundational concept are strong for example, to introduce the concept of repetition teacher can introduce it with a simple example like *Write an algorithm using flow chart or pseudocode to print the first five natural numbers.*

Once the students know the concept then students should be given enough opportunities to solve problems that require a combination of multiple concepts. *E.g.: Create a program to check if the given year is a leap year*

Evolution of Computers

To appreciate the development of computers and how it has progressed, students should be aware of the evolution of computers, but students are not expected to remember the chronology of development or the different models of computers or microprocessors.

Components of Computer System

Computer science course is considered a gateway for students to understand the digital world, and prepare them for the professional courses that lie ahead. In that sense, a basic introduction to the computer system is necessary while students should also be introduced to the latest developments that are fast becoming mainstream like the cloud etc.

Program Development

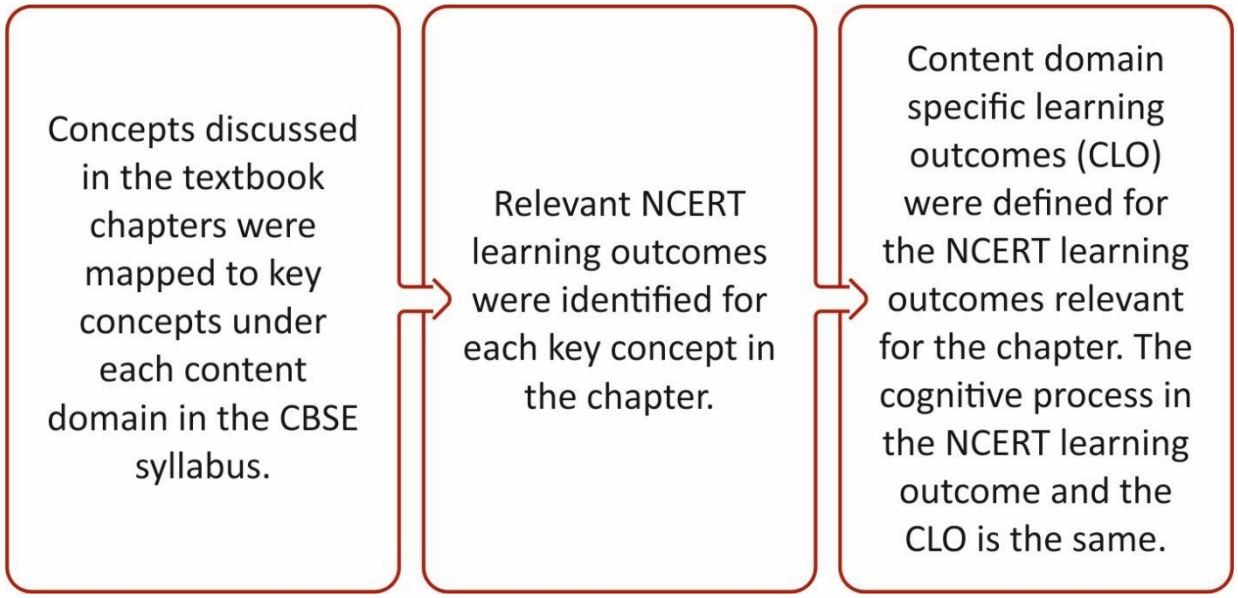
Students are expected to develop models and/or simulations using Python as the development environment to support the concepts in the syllabus. To enable this, students, have to be exposed to the need for different types of system software. They need to understand the features of a computer language, the process of converting a program in a higher-level language to machine understandable format and the need for compilers. The textbook introduces these concepts to students.

Databases

Students are expected to use database software to support the theoretical concepts within the syllabus. For this purpose, the course prescribes MySQL as a database development environment.

10. CONTENT DOMAIN-SPECIFIC LEARNING OUTCOME

The learning outcomes defined by CBSE are broadly defined for the content defined in the curriculum. They articulate the discipline-specific skills that students need to attain through learning different concepts in the syllabus. A clear understanding of the scope of these learning outcomes for each concept dealt with in the NCERT textbook chapters will be very helpful for both teachers and students in planning to teach and learn better. The following process has been followed to list out the content domain-specific learning outcomes (CLOs) and competencies for all the content units and textbook chapters.



CLASS 11

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
Chapter 1: Computer System	Components of Computer System	(1) Develop a basic understanding of computer systems - architecture, and operating systems.	CLO1. Recognize the different components of the computer system. This includes - Hardware – CPU, I/O devices, Storage - Software – Operating System, system software, Applications, Programming tools CLO2. Describe the principal functions of the components CLO3. Outline the relationship between the CPU, input and output and storage.
	Processor fundamentals	(1) Develop a basic understanding of computer systems - architecture, and operating systems.	CLO4. Explain the basic functioning of a computer system, including the purpose of the Arithmetic and Logic Unit (ALU), and Control Unit (CU). CLO5. Explain how factors contribute to the performance of the computer system - core, clock, cache CLO6. Explain how data are transferred between various components of the computer system using the address bus, data bus and control bus. CLO7. Explain how instructions and data are fetched-processed-executed
	Storage	(1) Develop a basic understanding of computer systems - architecture, and operating systems.	CLO8. State the purpose and need of different types of memory. CLO9. Distinguish between different types of memory.

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
			CLO10. State and use the binary magnitudes used in defining the memory.
Chapter 1: Computer System	Concept of Data	(1) Develop a basic understanding of computer systems - architecture, and operating systems.	CLO11. Explain the concept of data CLO12. Categorize data as Structured, Unstructured, or Semi-structured CLO13. Explain data capturing, processing, retrieval, and storage including the concept of data loss and recovery CLO14. Correlate the processes like data capture, processing, storage and retrieval with the components of a computer system like input, CPU and Memory respectively.
Chapter 2: Encoding Schemes and Number System	Data Representation	(2) Develop a basic understanding of various encoding schemes and number systems along with their applications in digital technology.	CLO15. Describe encoding and the need for it. CLO16. Represent character data in its internal binary form, depending on the character set used. CLO17. Demonstrate different number systems CLO18. Convert a value from one number base/representation to another. CLO19. use the basic Boolean operations(NOT, AND, OR, NAND, NOR, XOR) to process logical expressions. CLO20. Describe the need of using different number systems. For example, the relation between the hexadecimal representation of colours in computers.

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
Chapter 3: Emerging Trends **Chapter 3: Emerging Trends**	Emerging Technologies	(3) Develop a basic understanding of new technologies in Information technology and how are they affecting the modern lifestyle.	CLO21. Recognize some of the major advancements in the digital world CLO22. Describe the main characteristics and abilities of different emerging technologies. CLO23. Differentiate the various types of technologies Limited to – a) AI - Machine Learning (ML), Natural Language Processing (NLP), Immersive Experiences – VR and AR. b) Robotics c) Big Data d) Web of Things – IoT, Sensors, Smart cities e) Cloud Computing - IaaS, SaaS, PaaS f) Grid Computing g) Block Chain
	Impact of emerging technologies	(7) Understand the value of technology in societies along with consideration of gender and disability issues	CLO24. Critique how emerging technologies are impacting society.
Chapter 4: Introduction to Problem-Solving	Program development life cycle	(5) Develop basic principles of computational thinking.	CLO25. Understand the program development life cycle – analysis, design, coding and testing

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
			CLO26. Identify each stage and perform tasks related to each stage. • **analysis:** identification of the problem, decomposition of the problem, and identification of requirements. • **design:** decomposition, representation of Algorithm – Flowchart, Pseudocode • **coding:** writing program code • **testing:** testing program code with the use of test data
Chapter 4: Introduction to Problem Solving	Analysis and design	(4) Appreciate the notion of algorithms including flowcharts and pseudocode.	CLO27. Decompose a given problem into its components including input(s), process(es), and output(s). CLO28. Use different methods of design to construct the solution to a problem – flowchart and pseudocode. CLO29. State the purpose of an algorithm. CLO30. Describe the processes involved in an algorithm CLO31. Trace an algorithm and evaluate the value of the variable, output or prompts at each step
	Methods of solution		CLO32. Use the standard methods of the solution while designing an algorithm – sequence, selection and repetition.
	Verifying Algorithms		CLO33. Identify errors in given algorithms CLO34. Amend algorithms for given problems or scenarios

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
	Comparison of Algorithm		CLO35. Evaluate algorithms
Chapter 5: Getting Started with Python[2]	Python IDE	(6) Develop basic principles of computational thinking.	CLO36. Use Python to develop simple programs
	Python Tokens		CLO37. Use common Python tokens (Keywords, Identifiers, Constants, punctuators and operators) CLO38. Declare and use variables and constants CLO39. Use appropriate tokens to develop logical programs.
Chapter 5: Getting Started with Python	Data types	(5) Explain and use operators, variables and data types including higher-order data structures such as lists, tuples, and dictionaries.	CLO40. Justify the different data types and their characteristics. CLO41. Cite the purpose of mutable and immutable data types. CLO42. Select and use appropriate data types in a given scenario including its declaration and type conversion. CLO43. Evaluate the appropriateness of using different data types.
	Expressions	(6) Develop basic principles of computational thinking.	CLO44. Identify and use Arithmetic, logical, relational, assignment, identity and membership operators to create meaningful expressions for problem solutions.

[2] In order to develop the basic computational thinking, python is used here as a medium. Like with any programming language the student should be given enough opportunities to familiarise themselves with the features of Python, execution modes: interactive mode and script mode. The objective is not to test how well a student knows the language, but rather to assess how a student is able to apply computational thinking to solve the given problem.

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
	Statements		CLO45. Develop appropriate simple and nested statements for problem solutions.
	Input and output		CLO46. State and apply the concept of inputs and outputs in computational problem-solving. CLO47. Identify the inputs and outputs required in a solution. CLO48. Develop programs that can accept data as input from the user and display the output.
	Debugging		CLO49. Identify and suggest steps to remove programming errors – Limited to Runtime, syntax and logical errors
Chapter 6: Flow of Control	Concept of Sequence	(6) Develop basic principles of computational thinking.	CLO50. Identify and develop the appropriate sequence of steps required to solve a problem. CLO51. Evaluate whether the order in which tasks/statements are executed is in the right sequence to achieve the desired result.
	Concept of conditionals		CLO52. Identify when decision-making is required in a specified situation. CLO53. Identify the decisions required to solve a given problem statement. CLO54. Construct logical rules for solving the problem statement.

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
			CLO55. Explain the conditions that are used in a given situation. CLO56. Trace programs that use simple and compound conditional statements to deduce the output at different steps CLO57. Identify errors and suggest corrections required for the desired result in programs that use simple and compound conditional statements
	Concept of Iteration		CLO58. Identify when iterations are required and the number of iterations required to solve a given problem. CLO59. Use the appropriate iteration method to solve the given problem – including simple and nested loops. CLO60. Use breaks and continue appropriately while creating a program with iterations. CLO61. Identify errors and suggest corrections required for the desired result in programs that use simple and nested loops including count-controlled loops, pre-condition loops, and post-condition loops
Chapter 7: Functions	Concept of functions	(6) Develop basic principles of computational thinking.	CLO62. Use functions to achieve modularity and reusability.
	Scope of a Variable – global variable, local Variable		CLO63. Illustrate the scope of local and global variables. CLO64. Define local and global variables appropriately in a program that uses functions

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
			CLO65. Trace programs that use functions with local/global variables to deduce the output at different steps
	Using Functions		CLO66. Identify and use Python Standard Library CLO67. Define and use functions – including built-in and user-defined functions with and without argument and parameters CLO68. Trace and explain the flow of Execution of a program that uses functions. CLO69. Identify errors and suggest corrections required for the desired result in programs that use functions
Chapter 8: Strings **Chapter 8: Strings**	String Operations	(6) Develop basic principles of computational thinking.	CLO70. Construct a program or code sample that performs operations on strings to achieve the desired result like Accessing Characters in a String, Concatenation, Repetition, Membership operations, Slicing, and traversing the string CLO71. Use built-in string routines to construct the program. CLO72. Trace programs that have operations on strings to deduce the output at different steps. CLO73. Identify errors and suggest corrections required for the desired result in programs that have string operations
Chapter 9: Lists	Introduction to lists	(5) Explain and use operators, variables and data types	CLO74. Identify the utility of advanced data type – list including simple as well as nested lists.

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
		including higher-order data structures such as lists, tuples, and dictionaries.	CLO75. Identify when the data types should be defined as lists.
	List Operations	(6) Develop basic principles of computational thinking.	CLO76. Develop programs that require the use of lists to solve a given problem – including simple and nested lists like Accessing elements in a list, Concatenation, Repetition, Membership operations, Slicing, and Traversing the list. CLO77. Use built-in list routines to construct the programs CLO78. Trace programs that have operations on lists in order to deduce the output at different steps. CLO79. Identify errors and suggest corrections required for the desired result in programs that have list operations
Chapter 10: Tuples and Dictionaries	Introduction to Tuples	(5) Explain and use operators, variables and data types including higher-order data structures such as lists, tuples, and dictionaries.	CLO80. Identify the utility of advanced data type – Tuple – including simple as well as nested tuples. CLO81. Identify when to use a tuple to solve a problem. CLO82. Define a tuple.
	Tuple Operations	(6) Develop basic principles of computational thinking.	CLO83. Develop programs that require the use of tuples to solve a given problem – Including simple and nested tuples like accessing elements in a tuple, Concatenation, Repetition, Membership operations, Slicing, traversing the tuple etc. CLO84. Use built-in tuple routines to construct the program.

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
Chapter 10: Tuples and Dictionaries			CLO85. Trace programs that have operations on tuples to deduce the output at different steps. CLO86. Identify errors and suggest corrections required for the desired result in programs that have tuple operations
	Dictionary	(5) Explain and use operators, variables and data types including higher-order data structures such as lists, tuples, and dictionaries.	CLO87. Identify the utility of advanced data type – dictionary CLO88. Identify when to use dictionaries to solve a problem. CLO89. Define a dictionary – including simple as well as nested dictionaries.
	Dictionary Operations	(6) Develop basic principles of computational thinking.	CLO90. Develop programs that require the use of tuples to solve a given problem – including simple and nested dictionaries. These can include programs like accessing items in a dictionary using keys, adding a new item, modifying an existing item in a dictionary, and traversing a dictionary CLO91. Use built-in dictionary routines to construct the program. CLO92. Trace programs that have operations on dictionaries to deduce the output at different steps. CLO93. Identify errors and suggest corrections required for the desired result in programs that dictionaries operations
Chapter 11: Societal Impact	Digital Society	(7) Understand the value of technology in societies along	CLO94. Evaluate the role of the individual in the world of digital technology

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
Chapter 11: Societal Impact		with consideration of gender and disability issues.	CLO95. Reflect the growing trend of using digital technologies in various spheres of activities.
	Etiquettes in digital society	(6) explain cyber ethics, cyber safety and cybercrime	CLO96. Highlight the need for etiquette in digital activities.
	Data Protection		CLO97. Explain the concept of digital property and IP rights. CLO98. Cite the need for licensing and protection. CLO99. Distinguish between the different types of software licencing CLO100. justify the use of a licence for a given situation CLO101. Evaluate the impact of acting violating IP rights.
	Threats to technology		CLO102. Describe Cybercrime CLO103. Differentiate different types of cyber crimes.
	Role of governments in technology		CLO104. Critique the role of government in digital technologies CLO105. Explain the need for policies in safeguarding citizens in the digital world
	Changes in Lifestyle	(7) Understand the value of technology in societies along with consideration of gender and disability issues	CLO106. Evaluate the impact of change in our lifestyles due to digital advancements.

CLASS 12

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
Chapter 1: Exception Handling in Python	Exceptions	(4) Explain and use the concept of exception as well as file handling.	CLO1. Recognize the different types of exceptions and understand the need for handling exceptions. CLO2. State the various methods to raise an exception.
	Exception handling		CLO3. State methods to handle an exception in a given scenario. CLO4. Use exception handling appropriately to design a program code to catch all the exceptions.
Chapter 2: File Handling in Python	Introduction to files	(4) Explain and use the concept of exception as well as file handling.	CLO5. Recognize why files are needed and the purpose of storing data in a file to be used by a program CLO6. Identify the different types of files limited to text, CSV and binary files. CLO7. Identify when to use files to solve a problem.
	Operations on files		CLO8. Recognize when to use operations on files including - Open (in read, write, append mode) - opening a file using clause - close a file - Read a record from a file - Search a file

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
Chapter 2: File Handling in Python		(4) Explain and use the concept of exception as well as file handling.	- write a record to a file limited to Text, Binary and CSV file CLO9. Perform file-processing operations as required based on the given scenario including pickling CLO10. Write code/ code snippets to handle text files that consist of one or more lines CLO11. Trace programs that have operations on file to deduce the output at different steps. CLO12. identify errors and suggest corrections required for the desired result in programs that use file operations
Chapter 3: Stacks	Introduction to Data Structures	(5) Use basic data structure: Stacks and Queues.	CLO13. Relate the concept of data structure with data types like strings, lists etc. CLO14. Describe the most common data structures
	Stacks		CLO15. Describe the characteristics and applications of a stack. CLO16. Implement stacks in Python
	Stack operations		CLO17. Construct code/ code snippets using access methods of a stack to solve a given problem. CLO18. Trace programs that use stacks to deduce the output at different steps. CLO19. Identify errors and suggest corrections required for the desired result in programs that use stacks.

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
Chapter 4: Queues	Queues	(5) Use basic data structure: Stacks and Queues.	CLO20. Describe the characteristics and applications of a stack. CLO21. Implement Queues in Python
Chapter 4: Queues	Operations on Queue	(6) Use basic data structure: Stacks and Queues.	CLO22. Construct code/ code snippets using access methods of a stack to solve a given problem. CLO23. Trace programs that use Queues to deduce the output at different steps. CLO24. Identify errors and suggest corrections required for the desired result in programs that use Queues.
Chapter 5: Sorting	Sorting	(2) Implement search and sort techniques.	CLO25. Describe the need for sorting in linear data structures. CLO26. Demonstrate standard methods of sorting- insertion sort, selection sort and bubble sort methods CLO27. Construct code/ code snippets to perform the desired sort method to solve a given problem. CLO28. Create user-defined functions to perform the desired sort operation in a given scenario. CLO29. Trace programs that use a sorting method to deduce the output at different steps. CLO30. Identify errors and suggest corrections required for the desired result in programs that use a sorting method.

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
	Sorting efficiency	(5) Explain the concept of efficiency in algorithms and computing in general.	CLO31. Identify the conditions and choose the right sorting method in a given situation. CLO32. Analyse an algorithm to explain how a sorting algorithm will perform when the input grows larger.
Chapter 6: Searching **Chapter 6: Searching**	Searching	(2) Implement search and sort techniques. (2) Implement search and sort techniques.	CLO33. Describe the need for searching in linear data structures. CLO34. Show understanding of standard methods of Searching- linear search, binary search and searching by hashtag methods CLO35. Construct code/ code snippets to perform the desired search method to solve a given problem. CLO36. Trace programs that use a search method to deduce the output at different steps. CLO37. Identify errors and suggest corrections required for the desired result in programs that use a search method.
	Searching efficiency	(5) Explain the concept of efficiency in algorithms and computing in general.	CLO38. Identify the conditions and choose the right search method in a given situation. CLO39. Analyse an algorithm to explain how a search algorithm will perform when the input grows larger.
Chapter 7: Understanding Data	Database Concepts	(9) Use Database concepts, and SQL to store, retrieve and manipulate data.	CLO40. Distinguish between raw and processed data CLO41. Illustrate the need for data collection, storage, and processing.

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
			CLO42. Explain the concept of the relational data model CLO43. Outline the three important properties of a relation CLO44. Identify and explain the features of a relational data model.
	Statistical Techniques for Data Processing	(9) Use Database concepts, and SQL to store, retrieve and manipulate data.	CLO45. Formulate the mean, median, mode, range, and standard deviation of given data. CLO46. Choose the appropriate statistical method for a given problem
Chapter 8: Database Concepts	File system	(9) Use Database concepts, and SQL to store, retrieve and manipulate data.	CLO47. Justify the limitations of using a file-based approach for the storage and retrieval of data
	Database Management System		CLO48. Define what is a Database Management System CLO49. Recognize the key terms in DBMS like a Database schema, query, constraints, etc.
	Keys in a Relational database		CLO50. 7. Define and identify the different types of keys in the relational database
Chapter 9: Structured Query	SQL	(9) Use Database concepts, and SQL to store, retrieve and manipulate data.	CLO51. Explain the need for SQL
	Data types and constraints in MySQL		CLO52. Explain and identify the data types and constraints used in MySQL

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
Language (SQL)	SQL for data definition		CLO53. Identify and write MySQL queries to create, remove, and alter databases and tables.
	SQL for data manipulation		CLO54. Identify and write MySQL queries for inserting new records in a table
	SQL for retrieving data		CLO55. Identify and write MySQL queries for retrieving data using different clauses like DISTINCT, WHERE, GROUP BY etc.
	SQL for data updation and deletion		CLO56. Identify and write MySQL queries for updating and deleting data
Chapter 9: Structured Query Language (SQL)	Functions in SQL	(9) Use Database concepts, and SQL to store, retrieve and manipulate data.	CLO57. Understand how to use single-row, and multi-row functions and group records CLO58. Work with multiple tables in SQL
	Operations on Relations		CLO59. Apply binary operations to merge tuples of two tables
	Using two relations in a query		CLO60. Writing SQL queries using two relations using both JOIN and Cartesian product
	Network and types of Network	(7) Explain computer networks and how it works.	CLO61. Identify the different types of Networks – PAN, LAN, MAN and WAN

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
Chapter 10: Computer Networks			CLO62. Explain the characteristics and role of different types of networks.
	Network Devices		CLO63. Describe the role and functions of devices (like Modem, Hub, Switch, Repeater, Router, Gateway, etc.) in a computer network
	Network Topology		CLO64. Explain how data is transmitted between two devices for a given topology CLO65. Justify the use of a topology for a given situation
	Network fundamentals		CLO66. Recognize and explain the basic terminologies in computer networks like MAC, IP, URL, HTML, DNS etc. CLO67. Explain how an IP address is associated with a device on a network CLO68. Explain the IP address formats CLO69. Explain how a Uniform Resource Locator (URL) is used to locate a resource on the web including the role of the DNS server
Chapter 11: Data Communication	Basics of data communication	(7) Explain computer networks and how it works.	CLO70. Explain the concept of communication and the role of the major components in data communication. CLO71. Infer the capacity of a transmission media measured in terms of bandwidth and data transfer rate.

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
			CLO72. Explain different types of communication between different devices. CLO73. Choose a suitable type of communication in a given scenario. CLO74. Explain the role of switching techniques to connect the sender and receiver so that one-to-one communication is possible
	Data Transmission		CLO75. Recognize some of the major data transmission media and their suitability in different scenarios. CLO76. Distinguish between wired and wireless transmissions CLO77. Classification of transmission waves and their properties that are used in wireless transmission CLO78. Outline some of the latest technologies used in wireless communications
	Protocols		CLO79. Outline the importance of standardized language in the construction of networks. CLO80. Show an understanding of why a protocol is essential for communication in a network
Chapter 12: Security Aspects	Threats to data security	(8) Explain the security concerns in networked	CLO81. Identify the threats to computer and data security posed by networks and the internet like malware and viruses. Etc

Chapter	Key Concepts	CBSE Learning Outcome	Content domain-specific learning outcome
		computers and methods to mitigate them	CLO82. Explain different types of hackers and the methods used by them that pose a threat to data security CLO83. Explain the methods employed that pose a threat to network security like Denial of Service, Intrusion problems etc.
	Methods to combat the threats		CLO84. Describe methods that can be used to restrict the risks posed by threats CLO85. Explain how antivirus works.

11. SUGGESTED PEDAGOGICAL PROCESSES AND ASSESSMENT STRATEGIES

"The pedagogical practices should be learner centric. It is expected of a teacher to ensure an atmosphere for students to feel free to ask questions. They would promote active learning among students with a focus on reflections, connecting with the world around them, creating and constructing knowledge. The role of a teacher should be that of a facilitator who would encourage collaborative learning and development of multiple skills through the generous use of resources via diverse approaches for transacting the curriculum."

[CBSE Curriculum for classes 11-12]

NCERT higher secondary stage learning outcomes document provides a common set of pedagogical processes for each subject. Keeping these as guidelines, specific pedagogical processes and assessment strategies for a topic from one chapter each from classes 11 and 12 have been developed as suggestions and are shared in this section. These instances of pedagogical processes and assessment strategies should enable teachers to derive principles for making the alignment between learning outcomes, pedagogical practices and assessment in their classrooms and to use these for creating their lesson plans. The key principles considered while designing the pedagogical processes and assessment strategies are the following:

1. Keeping learners at the centre

- Since new knowledge is built over existing knowledge, both pedagogy and assessment should focus on students' pre-requisite knowledge, skills, attitudes, and beliefs that they bring into a classroom setting.
- Constructivist approaches to learning with the student being at the centre of the learning process as an active constructor of knowledge must be emphasized.
- Since students effectively learn by doing, classroom processes should involve activities, analysis and discussions. Systematic experimentation as a tool to discover/verify theoretical principles must be included.

2. Focusing on learning outcomes

- Learning outcomes indicate what a student will be able to do at the end of an instruction unit by precisely breaking down broad goals of chemistry education (apply reasoning to develop conceptual understanding, develop process skills and experimental, observational, manipulative, decision-making and investigatory skills, etc.) to more measurable and observable behaviour for each class.
- Students learn better when the method of teaching, learning activities and assessment strategies are all aligned well with the learning outcomes. Pedagogical processes and assessment strategies should be aligned to both content domains and cognitive skills as mentioned in this document earlier.

3. Making effective use of assessments

- Assessment should be viewed as an integral part of pedagogy and it should focus on giving timely individualized feedback to students.
- Quality formative assessment should be designed as it helps to modulate students' understanding of their learning and helps teachers adapt their pedagogy based on students' actual learning.
- Multiple modes of assessment including portfolios, project work, presentations, and written and oral assignments should be used to reflect the individual capacities of a student.

4. Creating a social and inclusive learning environment

- Cooperative and peer-supported teaching-learning activities should be used to empower students to take charge of their learning.
- Peer assessment involving students assessing the work of their peers against set assessment criteria should be used.
- Specific pedagogical processes should be used in the classroom that would help those students who may face learning difficulties including language, visual-spatial, or mixed processing problems.

12. SOME SAMPLE COMPUTER SCIENCE SPECIFIC PEDAGOGICAL PROCESSES AND ASSESSMENT STRATEGIES

GRADE: 11

Unit: Computational Thinking and Programming

Chapter: Flow of Control

Learning Outcome	Pedagogical Process	Assessment Strategies
CLO49. Identify and develop the appropriate sequence of steps required to solve a problem. CLO51. Identify when decision-making is required in a specified situation. CLO52. Identify the decisions required to solve a given problem statement. CLO57. Identify when iterations are required and no: of iterations required to solve a given problem. CLO53. Construct logical rules for solving the problem statement. CLO58. Use the appropriate iteration method to solve the given problem – including simple and nested loops. CLO59. Use break and continue appropriately while creating a program with iterations. CLO55. Trace programs that use simple and compound conditional statements to deduce the output at different steps	Students should be able to analyse a given problem statement and design the solution. To introduce the concepts of sequence, iteration and conditions. Students should be given to write simple solutions for real-world examples like - Algorithm to solve the problem of a non-functioning light bulb - Algorithm to make a well-balanced plate of Upma/Poha/Khichdi. - Choosing the best route for school - Grouping students whose height is more than 5 ft into group A and others in group B Such problems will help them develop computational thinking with relatable concepts. Once students are comfortable, students should be given computational problems to	check their skills 1) Students can be given problem statements to solve using different methods of problem-solving. 2) Students are expected to trace, explain or construct algorithms/code snippets to – check whether the code will produce the desired result, and evaluate an intermediate output at a particular step. 3) Given an error, students should be able to suggest suitable methods to solve the error. Students are not expected to know all the tokens, relevant stimuli and inserts should be provided in the paper to ensure that the assessment is for computational thinking and not about learning python syntax. The questions should not be about asking syntax-based questions which would need students to memorize the tokens.

CLO50. Evaluate whether the order in which activities are executed is in the right sequence to achieve the desired result. CLO56. identify errors and suggest corrections required for the desired result in programs that use simple and compound conditional statements CLO60. Identify errors and suggest corrections required for the desired result in programs that use simple and nested loops including count-controlled loops, pre-condition loops, post-condition loops	solve, the problems should be given at increasing levels of difficulty. Students should be introduced to the different programming concepts separately to gain procedural fluency in the programming as well as develop sequential, logical and recursive thinking. As a practice to develop the skill of writing algorithms as well as gaining procedural fluency, it should be made a standard practice to write the pseudocode/flowchart, before coding. Teachers should give enough hands-on experience in writing algorithms for different kinds of problem statements. Students should also be given as much practice time in computer labs as possible to develop programming familiarity while not forcing them to memorize the syntax. Programming on computers also will develop the skill of identifying errors and correcting them at the same time develop the skill of tracing the programs.	

GRADE: 12

Unit: Computer Networks **Chapter:** Security Aspects

Learning Outcome	Pedagogical Process	Assessment Strategies
CLO86. Show understanding of the threats to computer and data security posed by networks and the internet like malware, and viruses. Etc CLO87. Show an understanding of different types of hackers and the methods used by them that pose threat to data security CLO88. Explain the methods employed that pose a threat to network security like Denial of Service, Intrusion problems etc.	In an ever-increasing world of connected systems and devices, students need to have a broad view of the threats that pose a risk to their data security. Teachers should explain the different types of threats and also understand the reason why these threats are created. Students should be given the opportunity to explore different case studies that showcase the damages caused by the threats, this could be a group activity where students can go through the case study and give a short presentation on the case.	Students could be given case scenarios and asked the type of threat that is mentioned in the case and how they will ensure that the system is secure. Students could be asked to differentiate between different types of threats. Students could be asked to differentiate between different kinds of security systems. Students could also be asked to explain with examples how some of the commonly used elements are converted into a threat.
CLO89. Describe methods that can be used to restrict the risks posed by threats CLO90. Show an understanding of how antivirus works.	Teachers should explain the concept of network security measures Show a video document of setting up different security measures. Students could be asked to give a small write-up on different security measures and how those will protect them. Students should be presented with scenarios of different threats and ask them to identify the measures that they will take to create a secure scenario.	

CLASS 11

Chapter Name	**1.** Computer System	
Essential Idea	The computer system is made up of hardware and software components and together they perform complex activities	
Question 1		
Item Stem	Data entered through the input device is temporarily stored in i) RAM ii) ROM iii) Hard disk iv) CPU	
Correct answer	RAM	Reason: RAM is volatile
Distractor 1	ROM	Explanation: Confusion between RAM and ROM
Distractor 2	Hard Disk	Explanation: Lack of understanding of the concept of data storage and retrieval
Distractor 3	CPU	Explanation: Lack of understanding of the concept of data storage and retrieval
Question 2		
Item Stem	The size of computers reduced drastically due to i) Registers ii) Integrated circuits iii) Resistors	

	iv) RAM	
Correct answer	Integrated circuits	Reason: Since it is just a small chip, it helps reduce the size of the computers
Distractor 1	Registers	Explanation: Confusion between registers and IC
Distractor 2	Resistors	Explanation: Confusion between resistors and IC
Distractor 3	RAM	Explanation: Lack of understanding of computer systems

Question 3

Item stem	Fill in the blanks i) _____ language uses 0 and 1 for writing instructions ii) A high-speed memory placed between the CPU and the primary memory is known as _____ iii) The startup program that loads the operating system into the primary memory is ____ iv) _____devices feed data into the computer.

Marking Rubric

Description	**Marks**
i) Machine ii) Cache Memory iii) ROM iv) Input	4 (1 mark for each correct answer)

Chapter Name	**2.** Encoding schemes and Number systems	
Essential Idea	Encoding Schemes and number systems help humans communicate with computers effectively.	
Question 1		
Item Stem	When a key is pressed on the English keyboard, it is internally mapped to i) Unique hexadecimal code ii) Unique decimal code iii) Unique binary code iv) Unique octal code	
Correct answer	Unique decimal code	Reason: The keys are mapped to decimal numbers which are eventually converted to a binary value for the computer to understand
Distractor 1	Unique hexadecimal code	Explanation: Since it contains the alphabets as well, some students might get confused
Distractor 2	Unique binary code	Explanation: Since this is the code that the computer understands
Distractor 3	Unique octal code	Explanation: Octal code is also used in computers, so it may cause a confusion
Question 2		
Item Stem	ASCII code for A is 065, B is 066, S is 083 and T is 084. If the word “BATS” is input using an ASCII encoded keyboard. How would it be encoded into binary values which can be understood by a computer?	

	i. 01001001 01000001 01000011 01000101 ii. 01000101 01000010 01000011 01000101 iii. 01000101 01000010 01000011 01000111 iv. 01000010 01000001 01010100 01010011	
Correct answer	iv.	This is the correct ASCII equivalent of 7-bit binary code
Distractor 1	i.	Explanation: Lack of understanding of how ASCII code is converted into binary equivalent
Distractor 2	ii.	Explanation: Lack of understanding of how ASCII code is converted into binary equivalent
Distractor 3	iii.	Explanation: Lack of understanding of how ASCII code is converted into binary equivalent
Question 3		
Item stem	Do the following conversions: i) Decimal to Binary: 120 ii) Octal to decimal: 6760 iii) Decimal to hexadecimal: 4502	

Marking Rubric	
Description	**Marks**
i) 1111000 ii) 3568 iii) 1196	3 (1 mark for each correct answer)

Chapter Name	**3.** Emerging Trends	
Essential Idea	The rapid evolution of computer technology has transformed areas ranging from data infrastructure to cyber security.	
Question 1		
Item Stem	Which of the following does not come under Artificial Intelligence (more than one option can be correct)? i) Siri ii) Virtual Reality iii) Google Docs iv) Cryptocurrency	
Correct answer	iii) and iv)	Reason: Google Docs is an online word processor and cryptocurrency that used blockchain technology.
Distractor 1	Siri	Explanation: AI-based personal assistant
Distractor 2	Virtual Reality	Explanation: It is a part of the immersive experience
Question 2		
Essential Idea	Technology is evolving faster than ever to make to support and strengthen the human ability	
Item stem	Justify the statement 'Storage of data is cost-effective and time-saving in cloud computing.'	

Marking Rubric	
Description	**Marks**
Correct answer:	1

Cloud computing stores data on a server and it is available almost free of cost or nominal cost. When it comes to time-saving by saving data on the internet there is no need to wait to start up any computer or device. It is easily available with a browser program or app. So it can be accessed anytime from anywhere.	
Cloud computing stores data on a server and it is available almost free of cost or nominal cost.	0.5
When it comes to time-saving by saving data on the internet there is no need to wait to start up any computer or device. It is easily available with a browser program or app. So it can be accessed anytime from anywhere.	0.5

Chapter Name	**Introduction to Problem Solving**
Essential Idea	A problem-solving strategy is a plan of action used to find a solution.
Question 1	
Item Stem	Given the following pseudocode, what will be the output if the input is: 9,2,6,5,8,0,6,9,9. Step 1: Set c = 0, s = 0 Step 2: Input num Step 3: While num is not equal to 0, repeat Steps 4 to 6 Step 4: s = s + num Step 5: c = c + 1 Step 6: Input num Step 7: Compute a = s/c Step 8: Print a and c i) 6, 5 ii) 6, 6

	iii) 6, 9 iv) 5, 6	
Correct answer	6,5	Reason: It takes only the first 5 numbers
Distractor 1	6, 6	Explanation: Some students might also count 0 and the average will remain the same
Distractor 2	5, 5	Explanation: Some students might take in all the numbers
Distractor 3	5, 6	Explanation: Confusion with option i) (silly mistake)

Question 2	
Item stem	Write the pseudocode to input two numbers and swap them without using a third variable.

Marking Rubric	
Description	**Marks**
Correct answer: Step 1. Input a and b Step 2. Compute a = a+b Step 3. Compute b = a-b Step 4. Compute a = a-b	2
Step 1. Input a and b	0.5
Step 2. Compute a = a+b	0.5
Step 3. Compute b = a-b	0.5
Step 4. Compute a = a-b	0.5

Chapter Name	Getting started with Python	
Essential Idea	To learn the language, you need to know the vocabulary and the grammar to know how to construct well-formed "sentences".	
Question 1.		
Item Stem	Write the output of the following *a=5* *b=a* *a=10* *c = b!=a* *print(c)* i) 10 ii) True iii) 5 iv) False	
Correct answer	ii)	Reason: != returns a value of true or false. Since a is not equal to b, the value true would be returned.
Distractor 1	i)	Explanation: Lack of understanding of basic syntax and concept of objects
Distractor 2	iii)	Explanation: Lack of understanding of basic syntax and concept of objects
Distractor 3	iv)	Explanation: Lack of understanding of basic syntax and concept of objects
Question 2		

Item stem	i) Suppose there are 5 people (including you) working on a project and writing code in the same file. Now, if you want to tell some information about your code, how will you do so using just the code you have written? ii) What is the data type of A (where A = '101') iii) What will be the output of the following code? x=2 x=5 x=x+x print(x)

Marking Rubric	
Description	**Marks**
i) Write comments ii) String iii) 10	3 (1 mark for each correct answer)

Chapter Name	Flow of Control
Essential Idea	Programs are executed step by step, the order in which the code is executed is essential in problem-solving.
Question 1	
Item Stem	What is the output of the following Python code: *L = [13 , 12 , 21 , 16 , 35 , 7, 4]* *sum = 5* *sum1 = 3* *for i in L:* *if (i % 4 == 0):* *sum = sum + i* *continue* *if (i % 7 == 0):* *sum1 = sum1 + i* *print(sum , end=" ")* *print(sum1)* i) 37 67 ii) 35 66 iii) 37 66 iv) 35 65

Correct answer	iii) 37 66	
Distractor 1	i) 37 67	Explanation: Wrong calculation
Distractor 2	ii) 35 66	Explanation: Lack of understanding to properly trace an algorithm with conditionals
Distractor 3	iv) 37 65	Explanation: Lack of understanding to properly trace an algorithm with conditionals

Question 2

Item stem	Write a program to display the sum of odd numbers and the sum of even numbers separately that fall between two numbers (including both numbers) accepted by the user. (Note: use while loop)

Marking Rubric

Description	**Marks**
Correct answer: *num1 = int(input("Enter first number : "))* *num2 = int(input("Enter second number : "))* *sumEven = 0* *sumOdd = 0* *if num1 > num2 :* *while(num2 <= num1):* *if num2%2 == 0:* *sumEven = sumEven + num2* *num2 = num2 + 1*	4

else: *sumOdd = sumOdd + num2* *num2 = num2 + 1* *else :* *while(num1 <= num2):* *if num1 % 2 == 0:* *sumEven = sumEven + num1* *num1 = num1 + 1* *else:* *sumOdd = sumOdd + num1* *num1 = num1 + 1* *print("Sum of even numbers is : ", sumEven)* *print("Sum of odd numbers is : ", sumOdd)*	
num1 = int(input("Enter first number : ")) *num2 = int(input("Enter second number : "))*	0.5
sumEven = 0 *sumOdd = 0*	1
if num1 > num2 : *while(num2 <= num1):* *if num2%2 == 0:* *sumEven = sumEven + num2*	1

num2 = num2 + 1 *else:* *sumOdd = sumOdd + num2* *num2 = num2 + 1*	
else : *while(num1 <= num2):* *if num1 % 2 == 0:* *sumEven = sumEven + num1* *num1 = num1 + 1* *else:* *sumOdd = sumOdd + num1* *num1 = num1 + 1*	1
print("Sum of even numbers is : ", sumEven) *print("Sum of odd numbers is : ", sumOdd)*	0.5

Chapter name	Functions	
Essential Idea	Function is a like device that you can use can carry out a specified task.	
Question 1		
Item stem	What is the output of the following code: *def func(x = 1, y = 2):* *x = x + y* *y += 1* *print(x, y)* *func(y = 2, x = 1)*	
Marking Rubric		
Description		**Marks**
Answers: 3 3		2
Question 2		
Item stem	Write a program to create a function *employee_details()* using the following conditions: a) It should accept the employee's salary for 2 months and his/her name b) If the salary for the second month is missing, then assign a default value of 9000 to the second month's salary c) Display the average salary and the employee's name	
Marking Rubric		

Description	Marks
Correct answer: *def show_employee(name, salary1, salary2=9000):* *print("Name:", name, "Average salary:", ((salary1+salary2)/2))*	3
def show_employee(name, salary1, salary2=9000):	1.5
print("Name:", name, "Average salary:", ((salary1+salary2)/2))	1.5
Question 3	
Item Stem	What will be the output of the following program? *cc = 2* *if False:* *cc = 66* *def helmet():* *if True:* *cc = 40* *helmet()* *print(cc)* i) 66 ii) 40 iii) 2

	iv) Error	
Correct answer	iii) 2	Reason: No change in the original value of cc
Distractor 1	i) 66	Explanation: Unaware of how Boolean works
Distractor 2	ii) 40	Explanation: Not familiar with the concept of local variable
Distractor 3	iv) Error	Explanation: Not familiar with the concept of the scope of variables

Chapter Name	**Strings**	
Essential Idea	Strings are very useful when communicating information from the program to the user of the program	
Question 1		
Item Stem	What will be the output of the following Python code: *print ("Welcome TO My Blog"[2:6] + "Welcome TO My Blog"[5:9])* i) lcomme ii) lcomme T iii) lcomme To iv) IcommeTo	
Correct answer	ii)	Reason: it will concatenate “lcom” first string and “me T” from the second string
Distractor 1	i)	Explanation: Confusion with indexing

Distractor 2	iii)	Explanation: Confusion with indexing
Distractor 3	iv)	Explanation: Might forget the space

Question 2	
Essential Idea	Strings are very useful when communicating information from the program to the user of the program
Item stem	Write a function in Python that will return a string containing the first letter of every word in a given string with spaces.

Marking Rubric	
Description	**Marks**
Correct answer: *def firstLetterWord(str):* *result = ""* *v = True* *for i in range(len(str)):* *if (str[i] == ' '):* *v = True* *elif (str[i] != ' ' and v == True):* *result += (str[i])*	4

v = False *return result*	
def firstLetterWord(str):	0.5
result = "" *v = True*	0.5
for i in range(len(str)): *if (str[i] == ' '):* *v = True* *elif (str[i] != ' ' and v == True):* *result += (str[i])* *v = False*	2.5
return result	0.5

Chapter Name	**Lists**
Essential Idea	Lists are used to store multiple elements of different data types in a single variable that can be changed after creation.
Question 1	
Item Stem	Select all the correct options to copy the following list: L = [‘a’, ‘b’, ‘c’, ‘d’] i) newList = copy.copy(L)

	ii) newList = L.copy() iii) newList.copy(L) iv) newList = list(L)	
Correct answer	i) and iv)	Reason: Correct Syntax
Distractor 1	ii)	Explanation: Since it has the word copy, some students might also think it is an answer
Distractor 2	iii)	Explanation: Since it has the word copy, some students might also think it is an answer

Question 2	
Chapter Name	Lists
Essential Idea	Lists are used to store multiple elements of different data types in a single variable that can be changed after creation.
Item stem	Write a Python program to find and display the second largest number in a list (take it as *list1*)

Marking Rubric

Description	**Marks**
Correct answer: *list1 = [10, 20, 4, 45, 99]* *mx=max(list1[0],list1[1])* *secondmax=min(list1[0],list1[1])* *n =len(list1)* *for i in range(2,n):* *if list1[i]>mx:*	4

secondmax=mx *mx=list1[i]* *elif list1[i]>secondmax and * *mx != list1[i]:* *secondmax=list1[i]* *print("Second highest number is : ",* *str(secondmax))*	
mx=max(list1[0],list1[1]) *secondmax=min(list1[0],list1[1])*	1
n =len(list1) *for i in range(2,n):* *if list1[i]>mx:* *secondmax=mx* *mx=list1[i]* *elif list1[i]>secondmax and * *mx != list1[i]:* *secondmax=list1[i]*	2.5
print("Second highest number is : ", *str(secondmax))*	0.5

Chapter Name	**Tuples and Dictionaries**

Essential Idea	Tuples are used to store multiple elements of different data types in a single variable that cannot be changed after creation.	
Item Stem	What is the output of the following Python codes *a="blog"* *b=list(a)* *c=tuple(b)* *print(c)* i) Error ii) (‘b’, ‘l’, ‘o’, ‘g’) iii) [‘b’, ‘l’, ‘o’, ‘g’] iv) [‘blog’]	
Correct answer	ii)	Reason: Letters broken by list but displayed as a tuple
Distractor 1	i)	Explanation: Confusion between lists and tuples
Distractor 2	iii)	Explanation: Not clear with the basic functionality of tuples
Distractor 3	iv)	Explanation: Might consider the word as one
Question 2		
Item Stem	What is the output of the following Python codes *d = {"john":40, "peter":45}* *print(list(d.keys()))*	

	i) (“john”, “peter”) ii) (40, 45) iii) [40, 45] iv) [“john”, “peter”]	
Correct answer	iv)	Reason: Will display only the keys
Distractor 1	i)	Explanation: Not clear about the basic concepts of dictionary
Distractor 2	iii)	Explanation: Not clear about the basic concepts of dictionary
Distractor 3	ii)	Explanation: Not clear about the basic concepts of key in a dictionary

Chapter Name	**Tuples and Dictionaries**
Essential Idea	Mapping can help in adjusting the range or preparing the values for analysis
Question 3	
Item stem	Write a Python program to delete list of keys from the dictionary Given: *sample_dict = {* *"name": "Kelly",* *"age": 25,* *"salary": 8000,* *"city": "New york"* *}*

	# Keys to remove *keys = ["name", "salary"]*

Marking Rubric	
Description	**Marks**
Correct answer: *sample_dict = {* *"name": "Kelly",* *"age": 25,* *"salary": 8000,* *"city": "New york"* *}* *# Keys to remove* *keys = ["name", "salary"]* *for k in keys:* *sample_dict.pop(k)* *print(sample_dict)*	1

Chapter Name	Societal Impact	
Essential Idea	Technologies have a dramatic impact on our lives.	
Question 1		
Item Stem	Ram copied large pieces of text from a source without citing that source to present it as his work. This would be considered as_____. i) Plagiarism ii) Copyright Infringement iii) Patent Infringement iv) None of these	
Correct answer	i)	Plagiarism is the act of copying large pieces of text without citing the sources.
Distractor 1	iv)	Explanation: not clear about trademark
Distractor 2	iii)	Explanation: Confusion between patent infringement and plagiarism
Distractor 3	ii)	Explanation: Confusion between patent, copyright, and plagiarism
Question 2		
Item stem	What are the things that everyone should do to prevent and combat cybercrimes?	

Marking Rubric	
Description	**Marks**
If any three are written: (0.5 marks each)	1.5

i) Use antivirus software and keep it updated always ii) Avoid installing pirated software. Always download software from known and secure (HTTPS) sites iii) Do not visit or download anything from untrusted websites iv) Take regular backups of important data v) Always update the system software vi) Usually the browser alerts users about doubtful websites whose security certificate could not be verified; avoid visiting such sites vii) Use a strong password for web login, and change it periodically. Do not use the same password for all the websites. viii) While using someone else's computer, don't allow the browser to save passwords or auto-fill data, and try to browse in your private browser window ix) For an unknown site, do not agree to use cookies when asked for, through a Yes/No option. x) Perform online transactions like shopping, ticketing, and other such services only through well-known and secure sites xi) Always secure a wireless network at home with a strong password and regularly change it.	

Chapter Name	Exception Handling in Python	
Essential Idea	Runtime errors need to be handled so that the normal flow of the application can be maintained.	
Question 1		
Item Stem	Which of the following statements is false? i) A try-except block can have more than one except statements ii) One block of except statement cannot handle multiple exceptions iii) The finally block is always executed iv) When 1 == "1" is executed, no exception is raised.	
Correct answer	One block of except statement cannot handle multiple exceptions	Reason: A block of except statement can handle multiple exceptions
Distractor 1	A try-except block can have more than one except statements	Explanation: The statement is true
Distractor 2	The finally block is always executed	Explanation: Students may think that if except block is executed, then finally block is not executed
Distractor 3	When 1 == "1" is executed, no exception is raised.	Explanation: Some people may find this confusion and commit mistakes
Question 2		
Item stem	What will be the output of the following Python codes?	

	i) *def foo():* *try:* *return 1* *finally:* *return 2* *k = foo()* *print(k)* ii) *def foo(x):* *try:* *print(5/x)* *except ZeroDivisionError:* *print ("exception block")* *else:* *print ("else block")* *finally:* *print ("finally block")* *foo(0)* iii)

	try: *num = int(input("Enter a number: "))* *assert num % 2 == 0* *except:* *print("Not an even number!")* *else:* *rec = 1/num* *print(rec)* Suppose we enter: a) 4 b) 5

Marking Rubric

Description	**Marks**
Answers: i) 2 ii) exception block finally block iii) a) 0.25 b) Not an even number!	3
i) 2	1
ii) exception block	0.5
ii) exception block	1

Finally block	
iii) a) 0.25 - (0.5 marks) b) Not an even number! (0.5 marks)	1

Chapter Name	**File Handling in Python**	
Essential Idea	Performing operations on files to store data permanently for reusability.	
Question 1		
Item Stem	Which of the following statements is false? i) In text file, each file is terminated by a special character called EOL ii) *f= open("story.txt")* - This statement will open in write mode iii) It is important to to close a file after we are done with the read and write operations iv) When you open a file for writing, if the file does not exist, a new file is created.	
Correct answer	*f= open("story.txt")* - This statement will open the file in write mode	Reason: The statement will open the file in default (read) mode
Distractor 1	In text file, each file is terminated by a special character called EOL	Explanation: The statement is true
Distractor 2	It is important to close a file after we are done with the read and write operations	Explanation: Some students might not be aware of this concept

Distractor 3	When you open a file for writing, if the file does not exist, a new file is created.	Explanation: Students might think that it will give an error
Question 2		
Item stem	Write a function line_count() in Python to count and print the number of lines from a text file “sample.txt” which is not starting with the letter ‘A’.	

Marking Rubric	
Description	**Marks**
Correct answer: *def line_count():* *file = open("sample.txt","r")* *count=0* *for line in file:* *if line[0] not in 'A':* *count+= 1* *file.close()* *print("No of lines not starting with 'A'=",count)*	2
def line_count(): *file = open("sample.txt","r")*	0.5
count=0	0.5

for line in file: *if line[0] not in 'A':* *count+= 1*	
file.close()	0.5
print("No of lines not starting with 'A'=",count)	0.5

Chapter Name	**Stack**	
Essential Idea	Problems that require backtracking can be implemented using stack operations.	
Question 1		
Item Stem	Is the below evaluation of the postfix expression correct? Step 1: INPUT postfix expression in a variable, say postExp Step 2: For each character in postExp, REPEAT Step 3 Step 3: IF character is an operand THEN PUSH character on the Stack ELSE POP one element from the Stack, apply the operator on the popped elements and PUSH the computed value onto the Stack Step 4: IF Stack has a single element THEN POP the element and OUTPUT as the net result ELSE OUTPUT “Invaild Postfix expression”	
Correct answer	No	Reason: In step 3, we will need to pop 2 elements from the Stack

Distractor 1	Yes	Explanation: Some students might miss the popping of two elements from stack concept
Question 2		
Item stem	Write the output of the following Python code *def isEmpty(stk):* *if stk==[]:* *return True* *else:* *return False* *def Push(stk,item):* *stk.append(item)* *top=len(stk)-1* *def Pop(stk):* *if isEmpty(stk):* *print("Underflow")* *else:* *item=stk.pop()* *if len(stk)==0:* *top=None* *else:* *top=len(stk)*	

```
        print("Popped item is "+str(item))
def Display(stk):
  if isEmpty(stk):
    print("Stack is empty")
  else:
    top=len(stk)-1
    print("Elements in the stack are: ")
    for i in range(top,-1,-1):
      print (str(stk[i]))
stk=[]
top=None
Push(stk,1)
Push(stk,2)
Push(stk,3)
Push(stk,4)
Pop(stk)
Display(stk)
```

Marking Rubric

Description	**Marks**
Correct answer: Popped item is 4 (1 marks)	2

Elements in the stack are: (0.25 marks) 3 (0.25 marks) 2 (0.25 marks) 1 (0.25 marks)	

Chapter Name	**Queue**	
Essential Idea	Problems that require order needs to be maintained can be solved using Queues.	
Question 1		
Item Stem	Which of the following statements is true? i) Queue follows the LIFO principle ii) DEQUE is to remove one element from the back of the queue iii) In the deque, if insertion and deletion are done from the same end, it will behave as a stack iv) A pile of books lying on top of each other is an example of a queue.	
Correct answer	In the deque, if insertion and deletion is done from the same end, it will behave as a stack	Reason: Since the last element inserted will pop out first, it will follow the stack (LIFO) principle
Distractor 1	Queue follows the LIFO principle	Explanation: Queue follows FIFO principle
Distractor 2	DEQUE is used to remove one element from the back of the queue	Explanation: DEQUE can be used to perform push and pop operations from both sides of the queue

Distractor 3	A pile of books lying on top of each other is an example of a queue	Explanation: A pile of books follow LIFO principle. Hence, will behave like a stack
Question 2		
Item stem	What is the output of the following Python code? *def enqueue(data):* *queue.insert(0,data)* *def dequeue():* *if len(queue)>0:* *return queue.pop()* *return ("Queue Empty!")* *def display():* *print("Elements on queue are:");* *for i in range(len(queue)):* *print(queue[i])* *queue=[]* *enqueue(5)* *enqueue(6)* *enqueue(9)* *enqueue(5)* *enqueue(3)* *print("Popped Element is: "+str(dequeue()))* *display()*	

Marking Rubric	
Description	**Marks**
Correct answer: Popped Element is: 5 (0.5 marks) Elements on queue are: (0.5 marks) 3 (0.25 marks) 5 (0.25 marks) 9 (0.25 marks) 6 (0.25 marks)	2

SAS

Chapter Name	Sorting
Essential Idea	Efficient sorting is important to optimize programs that require input in a sorted manner.
Question 1	
Item Stem	Consider a list having 6 elements [8,7,13,1,9,-4]. Now, all three sorting techniques are applied to it individually. What will be the output after the first pass for all three sorting techniques? I) Bubble sort a) [-9,8,7,13,1,4] II) Selection sort b) [7,8,1,-9,4,13] III) Insertion sort c) [7,8,13,1,-9,4]

Correct answer	I-b, II-a, III-c	Reason: The respective sorting algorithms will give the following output after one pass
Distractor 1	I-a II-c III-b	Explanation: Confusion between three sorting algorithms
Distractor 2	I-c II-b III-a	Explanation: Confusion between three sorting algorithms
Distractor 3	I-b II-c III-a	Explanation: I-b II-c III-a
Question 2		
Item stem	Given an unsorted list 'arr', write a function findMinDiff() in Python to find and print the minimum difference between any pair in the list. The time complexity should be less than O(n^2). Example 1: arr = [2, 4, 5, 9, 7] O/P: 1 Example 2: arr = [3, 10, 8, 6] O/P: 2	
Marking Rubric		
Description		**Marks**
One possible correct answer: *def findMinDiff(arr):* *n = len(arr)*		3

for i in range(n-1): *for j in range(0, n-i-1):* *if arr[j] > arr[j + 1] :* *arr[j], arr[j + 1] = arr[j + 1], arr[j]* *diff = 10**20* *for i in range(n-1):* *if arr[i+1] - arr[i] < diff:* *diff = arr[i+1] - arr[i]* *print(diff)*	
def findMinDiff(arr):	0.5
n = len(arr) # (use any of three sorting algorithms) *for i in range(n-1):* *for j in range(0, n-i-1):* *if arr[j] > arr[j + 1] :* *arr[j], arr[j + 1] = arr[j + 1], arr[j]*	1
*diff = 10**20*	0.5
for i in range(n-1): *if arr[i+1] - arr[i] < diff:* *diff = arr[i+1] - arr[i]* *print(diff)*	1

Chapter Name	Searching	
Essential Idea	The appropriate search algorithm often depends on the information required and the data from which it has to be searched.	
Question 1		
Item Stem	In the list A = [5,6,77,88,99] and key = 88, how many iterations are done until the element is found (using binary search)?	
Correct answer	2	Reason: Iteration1: mid = 77; Iteration2: mid = 88
Distractor 1	1	Explanation: Might confuse with linear search
Distractor 2	3	Explanation: Confusion in searching algorithm
Distractor 3	4	Explanation: Might confuse iteration with the key position in the array
Question 2		
Item stem	Write the algorithm to implement binary search in Python.	

Marking Rubric	
Description	**Marks**
Correct answer: Step 1: SET first = 0, last = n-1 - (0.5 marks) Step 2: Calculate mid = (first+last)//2 - (0.5 marks) Step 3: WHILE first <= last REPEAT Step 4 - (0.5 marks) Step 4: IF numList[mid] = key - (2 marks)	4

PRINT “Element found at position”, " mid+1 STOP ELSE IF numList[mid] > key, THEN last = mid-1 ELSE first = mid + 1 Step 5: PRINT “Search unsuccessful” - (0.5 marks)	

Chapter Name	**Understanding Data**	
Essential Idea	A given raw data has to be processed using various techniques to derive the right information from it.	
Question 1		
Item Stem	Which of the following problem statements is mapped to the correct statistical method? i) Average height of students in a class: Standard deviation ii) The most popular color for bike after surveying the bike owners of a town: Mean iii) Find the dominant value from a set of values: Median iv) Most frequently occurring value from a set of values: Mode	
Correct answer	Most frequently occurring value from a set of values: Mode	Reason: The value which occurs most frequently will represent the mode
Distractor 1	Average height of students in a class: Standard deviation	Explanation: Confusion between range, standard deviation, and mean

Distractor 2	The most popular color for bike after surveying the bike owners of a town: Mean	Explanation: Might think that most popular colour will have mean closer to that value
Distractor 3	Find the dominant value from a set of values: Median	Explanation: Might confuse median and mode

Question 2		
Item stem	What are the different types of data? Explain with examples.	
Marking Rubric		
Part	**Description**	**Marks**
	One possible Correct answer: There are two broad categories in which data can be classified: i) Structured data ii) Unstructured data Structured data: Data which is organized and stored in a well-defined format like tables Example: A teacher storing the attendance of students. Unstructured data: Data which is not in the traditional row and column structure Example: Contents of email or newspaper.	2
	There are two broad categories in which data can be classified: i) Structured data ii) Unstructured data	1
	Structured data: Data which is organized and stored in a well-defined format like tables	1

	Example: A teacher storing the attendance of students.	
	Unstructured data: Data which is not in the traditional row and column structure Example: Contents of email or newspaper.	1

<table>
<tr><th>Chapter Name</th><th colspan="2">Database Concepts</th></tr>
<tr><td>Essential Idea</td><td colspan="2">Organising logically related data in a system is essential to manage and utilise the data efficiently and easily.</td></tr>
<tr><td colspan="3">Question 1</td></tr>
<tr><td>Item Stem</td><td colspan="2">Which of the following statements is true?
. DBMS is costlier than a file system
a. A relational data model is used for unstructured data
b. Each attribute in a database table must have a unique name
c. A DBMS can be created even without a database schema</td></tr>
<tr><td>Correct answer</td><td>a and c only</td><td>Reason: DBMS costs more than a file system. And, if attributes in a table have the same name, it will be an invalid table</td></tr>
<tr><td>Distractor 1</td><td>b and d only</td><td>Explanation: People might confuse the question with “false” rather than “true”</td></tr>
<tr><td>Distractor 2</td><td>a, c, d</td><td>Explanation: Students might not understand the importance of database schemas</td></tr>
<tr><td>Distractor 3</td><td>c and d only</td><td>Explanation: Might think that there is no extra cost while using a DBMS</td></tr>
<tr><td colspan="3">Question 2</td></tr>
<tr><td>Item stem</td><td colspan="2">Identify the primary and foreign keys in the following tables.
Table 1
<table>
<tr><th>Roll number</th><th>Name</th><th>Class</th></tr>
<tr><td>1</td><td>Ankit</td><td>11</td></tr>
</table>
</td></tr>
</table>

2	Aravind	11
3	Nishchal	12

Table 2

Class	Teacher	Subject
11	Arpit	Maths
11	Sridhar	English
12	Jagadish	Maths

Marking Rubric	
Description	**Marks**
Correct answer: Primary key: Roll number (1 mark) Foreign key: Class (1 mark)	2

Question 3	
Item stem	When is a composite primary key used? Explain with an example.
Marking Rubric	

<table>
<tr><th>Description</th><th>Marks</th></tr>
<tr><td>
Correct answer:

If no single attribute in a relation can uniquely distinguish the tuples, then more than one attribute is taken together as the primary key. Such a primary key consisting of more than one attribute is called a Composite Primary key. (1 mark)

Example: (1 mark)
<table>
<tr><th>Teacher Name</th><th>Class</th><th>Subject</th></tr>
<tr><td>Udit</td><td>11</td><td>English</td></tr>
<tr><td>Vipul</td><td>11</td><td>Maths</td></tr>
<tr><td>Kaushal</td><td>12</td><td>English</td></tr>
</table>

Here a combination of ‘Class’ and ‘Subject’ will be used to make a composite primary key.
</td><td>2</td></tr>
</table>

Chapter Name	Structured Query Language (SQL)	
Essential Idea	Query languages are used to access and manipulate data from the database in a standardized manner.	
Question 1		
Item Stem	Which of the following statements is false? . Truncate is not a DDL command a. PRODUCT command is used to combine records from one or more tables b. If we have not specified ASC or DESC after a SQL ORDER BY clause, DESC is used as the default c. UPDATE command is used to change the definition of a table in SQL i) a and b only ii) a b and c only iii) c and d only iv) All of the above (a, b, c, d)	
Correct answer	All of the above (a, b, c, d)	Reason: All the statements are false
Distractor 1	a and b only	Explanation: If order is not specified, ASC is used as default. And, confusion between UPDATE and ALTER commands
Distractor 2	a, b, c only	Explanation: Confusion between UPDATE and ALTER commands
Distractor 3	c and d only	Explanation: Confusion between PRODUCT and JOIN commands

Question 2

Item stem

Write the SQL queries for the following tables.

Table - EmployeeDetails

EmpId	FullName	ManagerId	DateOfJoining	City
121	John Snow	321	31/01/2014	Toronto
321	Walter White	986	30/01/2015	California
421	Kuldeep Rana	876	27/11/2016	New Delhi

Table - EmployeeSalary

EmpId	Project	Salary	Variable
121	P1	8000	500
321	P2	10000	1000
421	P1	12000	0

i) Write an SQL query to fetch all the employees who either live in California or work under a manager with ManagerId – 321

ii) Write an SQL query to upper case the name of the employee and lower case the city values.

iii) Write an SQL query to fetch employee names having a salary greater than or equal to 5000 and less than or equal to 10000.

Marking Rubric	
Description	**Marks**
Correct answer: i) SELECT * FROM EmployeeDetails WHERE City='California' OR ManagerId='321'; - (2 marks) ii) SELECT UPPER(FullName), LOWER(City) FROM EmployeeDetails; - (1 mark) iii) SELECT FullName FROM EmployeeDetails WHERE EmpId IN (SELECT EmpId FROM EmployeeSalary WHERE Salary BETWEEN 5000 AND 10000); - (2 marks)	5

Chapter Name	Computer Networks	
Essential Idea	Computer Networks have evolved into a very sophisticated field over the years and allowed information sharing and modern communication	
Question 1		
Item Stem	Which of the following statements is false? . The DNS server converts the domain name to the corresponding IP address a. The URL of a page is not always the same as its domain name b. HTTPS is safer than HTTP c. Interlinking of a collection of webpages is called the Internet	
Correct answer	d)	Reason: A website is the interlinking of a collection of web pages.
Distractor 1	a)	Explanation: Lack of understanding of the concept of a DNS server
Distractor 2	b)	Explanation: URL can contain information much more than just the domain name
Distractor 3	c)	Explanation: Unaware of the importance of HTTPS
Question 2		
Item stem	Differentiate between IP address and MAC address.	
Marking Rubric		

<table>
<tr><th>Description</th><th>Marks</th></tr>
<tr><td>Correct answer:
<table>
<tr><th>IP Address</th><th>MAC Address</th></tr>
<tr><td>1. IP address, also known as Internet Protocol address, is also a unique address that can be used to uniquely identify each node in a network.</td><td>0. MAC stands for Media Access Control. The MAC address, also known as the physical or hardware address, is a unique value associated with a network adapter</td></tr>
<tr><td>2. IP addresses can change if a node is removed from one network and connected to another network.</td><td>2. MAC addresses won’t change if a node is removed from one network and connected to another network.</td></tr>
</table></td><td>2</td></tr>
<tr><td>Difference 1 (definition of IP and MAC Addresses)</td><td>1</td></tr>
<tr><td>Difference 2</td><td>1</td></tr>
</table>

Chapter Name	Data Communication	
Essential Idea	Different transmission media and protocols have improved the ways of communication.	
Question 1		
Item Stem	Which of the following statements is false? i) HTTP and FTP work on a client-server model ii) If you connect your home computer to the server of an ISP through a modem, you are using PPP (Point to Point protocol) iii) The HTTP protocol ensures that each computer connected to the internet is assigned an IP address. iv) If the data speed between two computers is different, it will lead to a loss of data	
Correct answer	iii)	Explanation: NOT the feature of the HTTP protocol
Distractor 1	i)	Explanation: Students might not know that FTP too works on a client-server model
Distractor 2	ii)	Explanation: Confusion between PPP and TCP/IP protocol
Distractor 3	iv)	Explanation: One of the benefits of using protocols. Students might not be aware of the concept of data loss
Question 2		
Item stem	State which of the following statements is true or false. i) Higher the bandwidth, the higher the data transfer rate ii) Infrared waves are used for communication in TV remotes	

	iii) Higher the frequency, the greater the distance travelled by that wave

Marking Rubric	
Description	**Marks**
i) True - (0.5 mark) ii) True - (0.5 mark) iii) False - (0.5 mark)	1.5

Chapter Name	**Security Aspects**	
Essential Idea	The Internet is powerful, but there are security issues and potential threats.	
Question 1		
Item Stem	Which of the following is considered an unsolicited commercial email? i) Spam ii) Malware iii) Virus iv) Trojan	
Correct answer	i)	Reason: Commercial emails with invitations and/or links that are shady are considered as spam

Distractor 1	ii)	Explanation: Confusion between Malware and spam
Distractor 2	iii)	Explanation: Students might think that since some email contain shady links, it will lead to some virus in their system
Distractor 3	iv)	Explanation: The emails might contain emails that may look useful at first but might be malicious.

Question 2	
Item stem	What are some best practices to follow to prevent malware distribution?

Marking Rubric	
Description	**Marks**
If any three are written: (0.5 marks each) i) Using antivirus and anti-malware software and updating them regularly ii) Always check for a lock button in the address bar while making payments iii) Avoid entering sensitive (passwords, pins) or personal information on unknown or public computers. iv) Configure your browser security settings v) Never use pirated unlicensed software. Instead, go for Free and Open Source Software (FOSS) vi) Applying software updates and patches released by its manufacturers vii) Taking a regular backup of important data. viii) Enforcing firewall protection in the network ix) Avoid clicking on links or downloading attachments from unsolicited emails. x) Never share your online account or banking password/pins with anyone.	1.5

14. TEST PAPER DESIGN

The test papers for the final examination for class 12 should be balanced in terms of their coverage of content domains, cognitive domains and types of questions. However, the blueprint governing the design of the test papers should not be very rigid and should provide sufficient latitude to the paper setter so that the focus while setting the paper remains on the quality of questions and the overall balance of the test paper.

Computer Science will be assessed using two parts.

Part 1 – Theory – 70 Marks

Part 2 – Practical- 30 Marks

DISTRIBUTION OF MARKS

CLASS 11

Unit	Marks
1 Computer Systems and Organisation	10
2 Computational Thinking and Programming	45
3 Society, Law and Ethics	15
Total	**70**

CLASS 12

Unit	Marks
1 Computational Thinking and Programming	40
2 Computer Networks	10
3 Database Management	20
Total	**70**

The theory exams should test knowledge and understanding of the principles behind computer science as well as the main aim of the course, which is fostering the development of computational thinking skills and the application of these skills to solve problems. Therefore, the questions designed must be to check the logic and computational skill of the student and not how much syntax the student remembers.

Students are expected to explain concepts, apply knowledge, analyse and/or interpret data and/or respond to stimulus materials. Stimulus material can include: diagrams; article snippets; flow charts/pseudocode or code snippets and/or screen captures.

Candidates should be provided with an insert or a hint to use in the exam with built-in functions, operators and precedence of operators. This could be given at a question level or even at a paper level that can be referred to by the students.

15. ASSESSMENT OF PRACTICAL WORK

The internal assessment component, being practical and productive, forms an important part of the assessment of the computer science course. It should provide sufficient opportunities for the students to showcase their innovative skills while developing a practical solution to either a specified problem or an unanswered question. These skills will be evident in the use of complex design and algorithmic principles as well as rigorous testing leading to the development of a functional product.

DESIGN OF THE PRACTICAL EXAMINATION

Students are expected to conduct experiments, do practical activities and investigative projects throughout the course of 2 years, and are also required to take a practical examination at the end of each year.

CLASS 11

Sl No	Assessment Type	Description	Marks
			Total
1	Lab Test	Python program (60% logic + 20% documentation + 20% code quality)	12
2	Report File	Minimum 20 Python programs	7
3	Viva		3
4	Project	that uses most of the concepts that have been learnt Synopsis of the project to be submitted by the students (documentation only) Final coding + Viva voce	8
Total			**30**

CLASS 12

Sl No	Assessment Type	Description	Marks
			Total
1	Lab Test	Python program (60% logic + 20% documentation + 20% code quality)	7
		5 SQL Queries based on one/two table(s).	5
2	Report File	Minimum 18 Python programs SQL Queries – Minimum 5 sets using one table / two tables. Minimum 2 programs based on Python - SQL connectivity.	7
3	Viva	--	3
4	Project	that uses most of the concepts that have been learnt Synopsis of the project to be submitted by the students (documentation only) Final coding + Viva voce	8
Total			**30**

16. SUGGESTED EXPERIMENTS, PRACTICAL ACTIVITIES AND INVESTIGATIVE PROJECTS

CLASS 11

- Input a welcome message and display it.
- Input two numbers and display the larger / smaller number.
- Input three numbers and display the largest / smallest number.
- Generate a pattern of symbols or alphabets as given below

Pattern-1	Pattern-2	Pattern-3
*	1 2 3 4 5	A
**	1 2 3 4	AB
***	1 2 3	ABC
****	1 2	ABCD
*****	1	ABCDE

- Write a program to input the value of x and n and print the sum of the following series:
  - $1 + x + x^2 + x^3 + x^4 + \cdots x^n$
  - $1 - x + x^2 - x^3 + x^4 - \cdots x^n$
  - $x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} - \cdots \frac{x^n}{n}$
  - $x - \frac{x^2}{2!} + \frac{x^3}{3!} - \frac{x^4}{4!} - \cdots \frac{x^n}{n!}$
- Determine whether a number is a perfect number, an Armstrong number or a palindrome.
- Input a number and check if the number is a prime or composite number.
- Display the terms of a Fibonacci series.
- Compute the greatest common divisor and least common multiple of two integers.

- Count and display the number of vowels, consonants, uppercase, and lowercase characters in a string.
- Input a string and determine whether it is a palindrome or not; convert the case of characters in a string.
- Find the largest/smallest number in a list/tuple
- Input a list of numbers and swap elements at the even location with the elements at the odd location.
- Input a list of elements and sort in ascending/descending order using various sorting techniques.
- Input a list/tuple of elements, and search for a given element in the list/tuple.
- Input a list of numbers and find the smallest and largest number from the list.
- Create a dictionary with the roll number, name and marks of n students in a class and display the names of students who have scored marks above 75.

CLASS 12

Python Programming

- Write a code to find the factorial of a natural number.
- Write a code to find the sum of all elements of a list.
- Write a code to compute the nth Fibonacci number.
- Read a text file line by line and display each word separated by a #.
- Read a text file and display the number of vowels/consonants/uppercase/lowercase characters in the file.
- Remove all the lines that contain the character 'a' in a file and write it to another file.
- Create a binary file with name and roll number. Search for a given roll number and display the name, if not found display the appropriate message.
- Create a binary file with roll number, name and marks. Input a roll number and update the marks.
- Write a random number generator that generates random numbers between 1 and 6 (simulates a dice).
- Create a CSV file by entering user-id and password, and read and search for the password for the given user-id.

Python Programming

- Write a Python program to implement a stack and queue using a list.

Database Management

- Create a student table and insert data. Implement the following SQL commands on the student table:
  - ALTER table to add new attributes / modify data type/drop attribute
  - UPDATE table to modify data
  - ORDER By to display data in ascending/descending order
  - DELETE to remove tuple(s)
  - GROUP BY and find the min, max, sum, count and average
- Similar exercises may be framed for other cases.
- Integrate SQL with Python by importing a suitable module.

PROJECT WORK

The class project aims to create something tangible and useful using Python file handling/ Python-SQL connectivity. This should be done in groups of two to three students and should be started by students at least 6 months before the submission deadline. The aim here is to find a real-world problem that is worthwhile to solve and give them an understanding of how problems are solved in the real world.

The broad steps that students are expected to follow is a simple waterfall model.

1. Identification of a project:
2. Defining a plan:
3. Fixing a timeline
4. Monitoring the project and taking support
5. Arrive at the final outcome

Students are encouraged to visit local businesses and ask them about the problems that they are facing. For example, if a business is finding it hard to create invoices for filing GST claims, then students can do a project that takes the raw data (list of transactions), groups the transactions by category, accounts for the GST tax rates, and creates invoices in the appropriate format. Students can be extremely creative here. They can use a wide variety of Python libraries to create user-friendly applications such as games, software for their school, learning aid, and mobile applications, of course, to do some of these projects, some additional learning is required; this should be encouraged. Students should know how to teach themselves.

The students should be sensitised to avoid plagiarism and violations of copyright issues while working on projects. Teachers should take the necessary measures for this.

SUGGESTED PROJECTS

Project Title 1: Automation of Order Processing in a Restaurant

Project Title 2: Development of a Puzzle

Project Title 3: Development of an Educational Game

17. REFERENCES

1. NCERT textbooks: https://ncert.nic.in/textbook.php?keip1=0-8
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3. K–12 Computer Science Framework retrieved from http://www.k12cs.org.
4. B Past papers https://ibresources.org/ib-past-papers/

18. ACKNOWLEDGEMENTS

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