Annexure-4

Himachal Pradesh University

NAAC Accredited "A" Grade University
Gyan Path, Summer Hill,
Shimla -171005

3/4 Years Bachelors of Science in Artificial Intelligence

B. Sc. (AI)

Scheme and Syllabus

(In accordance with NEP)
Effective from Academic Session 2026-2027

Department of Data Science and Artificial Intelligence

Himachal Pradesh University Shimla - 5

Abbreviations Used:

ABC	ACADEMIC BANK OF CREDITS
AEC	ABILITY ENHANCEMENT COURSE
AI	ARTIFICIAL INTELLIGENCE
C	CREDITS
CO	COURSE OUTCOMES
DSC	DISCIPLINE SPECIFIC COURSE
DSE	DISCIPLINE SPECIFIC ELECTIVE
EE	EXTERNAL EXAMINATIONS
H	HOURS
HEI	HIGHER EDUCATION INSTITUTION
IA	INTERNAL ASSESSMENT
I/A/P/C	INTERNSHIP/APPRENTICESHIP/PROJECT/COMMUNITY OUTREACH
I/MDC	INTERDISCIPLINARY/MULTIDISCIPLINARY COURSE
L	LECTURES
MC	MINOR COURSE
P	PRACTICALS
PSO	PROGRAM SPECIFIC OUTCOMES
SEC	SKILL ENHANCEMENT COURSE
T	TUTORIALS
UG	UNDERGRADUATE
VAC	VALUE ADDED COURSE
WAP	WRITE A PROGRAM

Semester I

Sr. No	Course Code		Course Title	Contact Hrs/week			Total Hrs	C	Semester End Marks	
				L	T	P	H		EE	IA
1.	BSAI-101	DSC-A1	Fundamentals of Computer and Operating Systems	**4**	**0**	**0**	**60**	**4**	70	30
2.	BSAI-102	DSC-B1	Programming using C	**4**	**0**	**0**	**60**	**4**	70	30
3.	BSAI-103	MDC-1	Linear Algebra	**3**	**0**	**0**	**45**	**3**	50	25
4.	BSAI-104	AEC-1	AEC-I from corresponding Bucket	**2**	**0**	**0**	**30**	**2**	35	15
5.	BSAI-151	SEC-1	Programming using C - Lab	**0**	**0**	**6**	**90**	**3**	50	25
6.	BSAI-152	MC-1	Linux Operating System - Lab	**0**	**0**	**8**	**120**	**4**	70	30
TOTAL								**20**	**345**	**155**
									Total = 500	

Semester II

Sr. No	Course Code		Course Title	Contact Hrs/week			Total Hrs	C	Semester End Marks	
				L	T	P	H		EE	IA
1.	BSAI-201	DSC-A2	Introduction to Data Structures	**4**	**0**	**0**	**60**	**4**	70	30
2.	BSAI-202	DSC-B2	Database Management System	**4**	**0**	**0**	**60**	**4**	70	30
3.	BSAI-203	MDC-2	Probability and Statistics	**3**	**0**	**0**	**45**	**3**	50	25
4.	BSAI-204	I/A/P/C-1	**As per the guidelines of H.P. University, Shimla**							
5.	BSAI-205	VAC-1	VAC-I from corresponding Bucket	**2**	**0**	**0**	**30**	**2**	35	15
6.	BSAI-251	SEC-2	Data Structures using C - Lab	**0**	**0**	**6**	**90**	**3**	50	25
7.	BSAI-252	MC-2	Database Management System - Lab	**0**	**0**	**8**	**120**	**4**	70	30
TOTAL								**24**	**Total = 600**	

I/A/P/C will be determined before the end of first semester to enable students to carry out some I/A/P/C activities during winter vacation.

Level: 4.5 (Exit-1) ***Students exiting the programme after securing 44 credits will be awarded UG Certificate in the relevant Discipline /Subject provided 6 credits from skill-based courses earned during first and second semester.***

Also, the students are required to opt for one course of English and Hindi each from the bucket of AEC during the first 2 years.

Semester III

Sr. No	Course Code		Course Title	Contact Hrs/week			Total Hrs	C	Semester End Marks	
				L	T	P	H		EE	IA
1.	BSAI-301	DSC-A3	Introduction to Python Programming	4	0	0	60	4	70	30
2.	BSAI-302	DSC-B3	Design and Analysis of Algorithms	4	0	0	60	4	70	30
3.	BSAI-303	MDC-3	Discrete Mathematics	3	0	0	45	3	50	25
4.	BSAI-304	AEC-2	AEC-II from corresponding Bucket	2	0	0	30	2	35	15
5.	BSAI-305	VAC-2	Artificial Intelligence for Everyday Use	2	0	0	30	2	35	15
6.	BSAI-351	SEC-3	Introduction to Python Programming - Lab	0	0	6	90	3	50	25
7.	BSAI-352	MC-3	Design and Analysis of Algorithms using C - Lab	0	0	8	120	4	70	30
TOTAL								22	380	170
									Total = 550	

Semester IV

Sr. No	Course Code		Course Title	Contact Hrs/week			Total Hrs	C	Semester End Marks	
				L	T	P	H		EE	IA
1.	BSAI-401	DSC-A4	Web Technologies & Network Security	4	0	0	60	4	70	30
2.	BSAI-402	DSC-B4	Machine Learning	4	0	0	60	4	70	30
3.	BSAI-403	DSE-1	Calculus	4	0	0	60	4	70	30
4.	BSAI-404	AEC-3	AEC-III from corresponding Bucket	2	0	0	30	2	35	15
5.	BSAI-405	VAC-3	Soft Computing	2	0	0	30	2	35	15
6.	BSAI-451	MC-4	Machine Learning using Python - Lab	0	0	8	120	4	70	30
TOTAL								20	350	150
									Total = 500	

Level: 5 (Exit-2) ***Students exiting the programme after securing 86 credits will be awarded UG Diploma in the relevant Discipline /Subject.***

Semester V

Sr. No	Course Code		Course Title	Contact Hrs/week			Total Hrs	C	Semester End Marks	
				L	T	P	H		EE	IA
1.	BSAI-501	DSC-A5	Introduction to Neural Networks and Deep Learning	4	0	0	60	4	70	30
2.	BSAI-502	DSC-B5	Introduction to R Programming	4	0	0	60	4	70	30
3.	BSAI-503	DSE-2	Natural Language Processing	4	0	0	60	4	70	30
4.	BSAI-504	MC-5	Natural Language Processing using Python- Lab	0	0	8	120	4	70	30
5.	BSAI-551	DSE-3	Neural Networks and Deep Learning using Python - Lab	0	0	8	120	4	70	30
6.	BSAI-552	AEC-4	R Programming - Lab	0	0	4	60	2	35	15
TOTAL								22	385	165
									Total = 550	

Semester VI

Sr. No	Course Code		Course Title	Contact Hrs/week			Total Hrs	C	Semester End Marks	
				L	T	P	H		EE	IA
1.	BSAI-601	DSC-A6	Computer Vision and Image Processing	4	0	0	60	4	70	30
2.	BSAI-602	DSC-B6	Robotics and Control Systems	4	0	0	60	4	70	30
3.	BSAI-603	DSE-4	Advances in AI	4	0	0	60	4	70	30
4.	BSAI-604	DSE-5	Software Engineering with AI	4	0	0	60	4	70	30
5.	BSAI-651	MC-6	Robotics and Control System - Lab	0	0	8	120	4	70	30
TOTAL								20	350	150
									Total = 500	

Level: 5.5 (Exit-3) ***Students who want to undertake 3-year UG programme will be awarded UG Degree in the relevant Discipline /Subject upon securing 128 credits.***

An individual seeking admission to the bachelor's degree (Honours/ Honours with Research) in a specified field of learning would normally have completed all requirements of the relevant 3-year Bachelor's degree. (After completing the requirements of a 3-year bachelor's degree, candidates who meet a minimum 75% marks or its equivalent grade will be allowed to continue studies in the fourth year of the undergraduate programme leading to the bachelor's degree (Honours with Research).

Instructions for ABC Credit Transfer After Each Exit Level at UG

1. **Exit Options and Credit Requirements:**
   - **Certificate (1 Year Exit):**
     - **Eligibility:** After completing 1 year (2 semesters) of the undergraduate program.
     - **Credit Requirement: 44 credits** must be earned.
     - **Award:** Students are eligible to receive an undergraduate **Certificate**.
   - **Diploma (2 Year Exit):**
     - **Eligibility:** After completing 2 years (4 semesters) of the undergraduate program.
     - **Credit Requirement: 86 credits** must be earned.
     - **Award:** Students are eligible to receive an undergraduate **Diploma**.
   - **Bachelor's Degree (3 Year Exit):**
     - **Eligibility:** After completing 3 years (6 semesters) of the undergraduate program.
     - **Credit Requirement: 128 credits** must be earned.
     - **Award:** Students are eligible to receive a **Bachelor's Degree**.
   - **Bachelor's Degree Honours /Honours with Research/Additional Specialization (4 Year Exit):**
     - **Eligibility:** After completing 4 years (8 semesters) of the undergraduate program.
     - **Credit Requirement: 168 credits** must be earned.
     - **Award:** Students are eligible to receive a **Bachelor's Degree Honours /Honours with Research** or an additional specialization in a major area.
2. **Process for Credit Transfer:**
   - **Credit Accumulation:** As students complete each semester, their credits will be stored digitally in their ABC account.
   - **Exit and Re-entry Options:**
     - If a student decides to exit at any of the prescribed levels, the corresponding credits will remain in their ABC account.
     - Upon re-entry into the same or another program (even at a different institution), students can transfer their stored credits to resume their education without losing academic progress.
3. **Eligibility for Transfer:**
   - Credits earned from courses successfully completed at the recognized HEI will be automatically reflected in the student's ABC account.
   - If students transfer to another institution, they must ensure that the credits are accepted by the receiving institution under the ABC framework.
4. **Credit Validity:**
   - Credits stored in the ABC are valid for a specified period (as per the institution's or university guidelines), allowing students flexibility to re-enter their education at any time within that period.
5. **Degree Award and National Recognition:**
   - Upon successful completion of the required credits for any exit level, the respective degree/diploma/certificate will be awarded by the university or HEI.

- The degree/diploma/certificate will have national recognition, allowing students to utilize the qualification for employment or further studies.

6. **Re-entry and Continuing Education:**
   - Students who re-enter the program can either continue accumulating credits towards the next exit level or pursue additional specializations in alignment with the multidisciplinary framework of NEP 2020.
   - Students are encouraged to complete the 4-year undergraduate program to enhance their qualifications, especially if they wish to pursue postgraduate studies or research.

DETAILED SYLLABUS

SEMESTER I

Name of the Course	FUNDAMENTALS OF COMPUTER AND OPERATING SYSTEMS		
Course Code	BSAI-101	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 70**	**Min Pass Marks: 35%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 15 marks, Tutorials/ Assignments & Presentation 10 marks, Attendance 5 marks)			**Min Marks: 35%** **Max Marks: 30**
Minimum aggregate pass marks should be 40%(35% in each component i.e. semester end examination and IA)			

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Gain a working knowledge of computer hardware components, their functionalities, and interactions.
CO2	Comprehend the role of software in computer systems and explore basic programming concepts.
CO3	Understand and manage core operating system functions, including process and thread management, inter-process communication, synchronization, and deadlock handling.
CO4	Comprehend and apply concepts of memory management, file system interfaces and implementation, secondary storage structures, and security measures in operating systems

INSTRUCTIONS

For Paper Setters: There will be 5 Parts(A,B,C,D,E) and the examiner shall set 9 questions in total from all the Sections/Blocks(I, II, III, IV) and each question shall carry 14 marks. Part A,B,C, and D will have 2 questions from each Section/Block I, II, III, IV respectively of the syllabus and Part E will have 10 short answer questions from all the Sections/Blocks of the syllabus(I,II,III,IV) carrying 2 marks each.

**Each Section/Block, preferably may have 1-2 units.*

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and 7 questions out of 10 questions given in Section E in total carrying 2 marks each. Use of non-programmable calculators is allowed.

BSAI-101 FUNDAMENTALS OF COMPUTER AND OPERATING SYSTEMS

UNIT – I

Introduction to Computers: History, types, components (CPU, memory, storage), peripherals.
Computer Hardware: Detailed hardware components, system units, peripherals.
Computer Software: Types of software (system vs. application), operating systems (Windows, macOS, Linux).

Data Representation and Operations: Binary, octal, decimal and hexadecimal systems, data storage units, basic operations (fetch-decode-execute cycle).

UNIT – II

Introduction to Programming: Basics of programming languages (C, C++, Python, JavaScript), variables, data types, control structures.
Data Management and Databases: Database types (relational, NoSQL), basic SQL queries, data management.
Computer Networks and Security: Basics of networks (LAN, WAN, internet), topologies, protocols, cybersecurity fundamentals.
Emerging Technologies: Trends (cloud computing, AI, IoT), societal impact.

UNIT-III

Operating Systems Overview: Definition & Functions, Types of Systems, Computer System Structure, Operating System Services.
Process Management: Process Concept, Process Scheduling, algorithms (FCFS, SJF, Priority, Round Robin, Multilevel Queue, Multilevel Feedback Queue), multiple processor, and real-time scheduling.
Threads & IPC: Threads, inter-process communication, Cooperating Processes, Process Synchronization, Critical Section Problem
Synchronization Tools: Hardware support, semaphores, Classical Problems
Deadlocks: Deadlock Characterization, Handling Methods: Prevention, avoidance, detection, and recovery.

UNIT-IV

Memory Management: Address Space, Swapping, Allocation, Paging, Segmentation, Virtual Memory, Demand Segmentation.
File System Interface: File Concept, Access Methods, Directory Structure.
File System Implementation: File System Structure, Allocation Methods (contiguous, linked, indexed), Free Space Management (bit vector, linked list, grouping, counting), Directory Implementation (linear list, hash table), Efficiency and Performance, Recovery (consistency checking, backup and restore)
Secondary Storage Structure: Disk Structure, Disk Scheduling (FCFS, SSTF, SCAN, C-SCAN, Look), Disk Management (disk formatting, boot block, bad blocks)
Security Problems, Authentication (passwords), Program Threats (worms, viruses), System Threats (threat monitoring, encryption)

Text Books:

1. Silberschatz, Galvin, “Operating System Concepts”, Addison Wesley Publishing Company, 1989.
2. Pradeep K. Sinha, Priti Sinha, “Computer Fundamentals”. BPB Publications.

Reference Books:

1. William Stallings, “Operating Systems”, Macmillan Publishing Company.

2. Deitel H.M., “An Introduction To Operating System”, Addison Wesley Publishing Company, 1984.
3. Tanenbaum, A.S., “Modern Operating System”, Prentice Hall of India Pvt.Ltd.
4. Rajaraman, V., “Fundamental of Computers”. Prentice Hall India, New Delhi.

Name of the Course	Programming using C		
Course Code	BSAI-102	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 70**	**Min Pass Marks: 35%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 15 marks, Tutorials/ Assignments & Presentation 10 marks, Attendance 5 marks)			**Min Marks: 35%** **Max Marks: 30**
Minimum aggregate pass marks should be 40%(35% in each component i.e. semester end examination and IA)			

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain core C programming concepts like data types, operators, control flow, and functions.
CO2	Implement input/output operations, looping constructs, and arrays for data organization.
CO3	Utilize user-defined functions for modular and reusable code.
CO4	Apply pointers for memory management and handle file processing tasks.

INSTRUCTIONS

For Paper Setters: There will be 5 Parts(A,B,C,D,E) and the examiner shall set 9 questions in total from all the Sections/Blocks(I, II, III, IV) and each question shall carry 14 marks. Part A,B,C, and D will have 2 questions from each Section/Block I, II, III, IV respectively of the syllabus and Part E will have 10 short answer questions from all the Sections/Blocks of the syllabus(I,II,III,IV) carrying 2 marks each.

**Each Section/Block, preferably may have 1-2 units.*

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and 7 questions out of 10 questions given in Section E in total carrying 2 marks each. Use of non-programmable calculators is allowed.

BSAI-102 Programming using C

UNIT – I

OVERVIEW OF C

History, Importance, Sample Programs , Basic Structure, Programming Style , Constants, Variables, and Data Types: Character Set, C Token, Keyword and Identifiers, Constants, Variables, Data Types ,Declaration of Storage Class, Assigning Values to Variables, Defining Symbolic Constants, Declaration ,Overflow and Underflow of Data , Operators and Expressions: Arithmetic, Relational, Logical, Assignment, Increment and Decrement,

Conditional, Bitwise, Special Operator, Arithmetic Expressions, Evaluation of Expressions ,Precedence of Arithmetic Operators –Some Computational Problems ,Type Conversions in Expressions ,Operator Precedence and Associativity ,Mathematical Functions .

UNIT - II

MANAGING INPUT AND OUTPUT OPERATIONS

Reading, Writing a Character, Formatted Input, Output, Decision Making and Branching: Decision Making with If statement ,Simple If Statement ,The If...Else Statement ,Nesting of If...Else Statements ,The Else If

Ladder ,The Switch Statement, The Ternary Operator ,The Goto Statement , Decision Making and Looping: The while Statement ,The do Statement –The for Statement ,Jumps in Loops ,Concise Test Expressions.

UNIT-III

ARRAYS

One, Dimensional Arrays , Declaration, Initialization of One Dimensional Arrays ,Two Dimensional Arrays , Initializing Two Dimensional Arrays ,Multi Dimensional Arrays , Character Arrays and Strings: Declaring and Initializing String Variables ,Reading Strings from Terminal ,Writing Strings to Screen, Comparison of Two Strings –String, Functions , User Defined Functions: Need for User Defined Functions ,A Multi Function Program ,Elements of User-Defined Functions ,Definition of Functions ,Return Values and Their Types ,Function Calls ,Function Declaration ,Category of Functions ,No Arguments and No Return Values ,Arguments but no return values ,Arguments with Return Values, No Arguments but Returns a value, Functions that Return Multiple Values, Nesting of Functions ,Recursion, Passing Arrays, Strings to Functions ,The Scope, Visibility and Lifetime of Variables .

UNIT-IV

STRUCTURE AND UNIONS

Defining a Structure ,Declaring Structure Variables, Accessing Structure Members –Structure Initialization and Copying and Comparing Structure Variable, Operations on Individual Member, Arrays of Structures, Arrays within Structures, Structures within Structures, Structures and Functions, Unions ,Size of Structures, Bit Fields Pointers: Understanding Pointers, Accessing the Address of Variable ,Declaring, Initialization of Pointer Variables ,Accessing a Variable through its pointer ,Chain of Pointers ,Pointer Expression ,Pointer Increments and Scale Factor, Pointers and Arrays, Array of Pointers.

Text Book:

1. E. Balagurusamy, "Programming in ANSI C", Tata McGraw-Hill Education, 8th Edition, 2018.

Reference Books:

1. Brian W. Kernighan, and Dennis M. Ritchie, "The C Programming Language (ANSI C)", Prentice-Hall, 2nd Edition, 1988.
2. W.S Foster & M.A Foster, "C by Discovery", Penram International Publishers, Mumbai,1991

Name of the Course	**LINEAR ALGEBRA**		
Course Code	BSAI-103	Credits-3	L-3, T-0, P-0
Lectures to be Delivered	45 (1 Hr Each) (L=45, T=0 for each semester)		
Semester End Examination	**Max Marks: 50**	**Min Pass Marks: 35%**	**Max. Time: 2 hrs**
Internal Assessment (based on sessional test (2) 10 marks, Tutorials/ Assignments & Presentation 10 marks, Attendance 5 marks)			**Min Marks: 35%** **Max Marks: 25**
Minimum aggregate pass marks should be 40%(35% in each component i.e. semester end examination and IA)			

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Perform matrix operations and analyze basic properties.
CO2	Explain vector spaces, solve linear systems, and apply basis and dimension concepts.
CO3	Analyze linear transformations and perform matrix factorization.
CO4	Utilize inner product spaces and apply diagonalization techniques.

INSTRUCTIONS

For Paper Setters: There will be 4 Parts (A, B, C, D) and the examiner shall set 7 questions in total from all the Sections/Blocks (I, II, III) of the syllabus in total. Part A, B, and C will have 2 questions from each Section/Block I, II, III respectively of the syllabus carrying 12 marks each and Part D will have 10 short answer questions from all the Sections/Blocks of the syllabus (I, II, III) carrying 2 marks each.

**Each Section/Block, preferably may have 1-2 units.*

For candidates: Candidates are required to attempt four questions in all selecting one question from each of the sections A, B, & C of the question paper and 7 questions out of 10 questions given in Section D in total carrying 2 marks each. Use of non-programmable calculators is allowed

BSAI-103 **LINEAR ALGEBRA**

UNIT-I

Matrix and Basic Properties of Matrix & Vectors: Matrix, scalar multiplication, linear transformation, transpose, conjugate, rank, determinant, Inner and outer products, matrix multiplication rule and various algorithms, matrix inverse, square matrix, identity matrix, triangular matrix, idea about sparse and dense matrix, UNIT vectors, symmetric matrix, Hermitian, skew-Hermitian and unitary matrices, Projection matrix, orthogonal matrix, idempotent matrix, partition matrix and their properties.

UNIT-II

Special Matrices and Vector Space: Matrix factorization concept/LU decomposition, Gaussian/Gauss-Jordan elimination, solving Ax=b linear system of equation, vector space, subspaces, basis, span, dimension of subspace, orthogonality, orthonormality, linear least square, Eigenvalues, eigenvectors, and diagonalization.

Linear Transformations - Definition and example of linear transformation, Null space, range, rank and nullity of linear transformation, matrix representation of a linear transformation, dual space, dual basis, double dual, composition of linear transformation and matrix multiplication, Singular Value Decomposition (SVD).

UNIT-III

Inner Product Spaces - Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.

Transformation Diagonalization: Diagonalizability, matrix Limits and Markov Chains and the Caley- Hamilton Theorem

Text Books:

1. Gilbert Strang , “Introduction to Linear Algebra”, Wellesley-Cambridge Press, 6th edition, 2023.
2. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, Pearson Education, 5th edition, 2021.

Reference Books:

1. David C. Lay, Linear Algebra and its Applications, Pearson Education, 6th edition, 2021.
2. Sheldon Axle, Linear Algebra Done Right, Springer, 4th edition, 2023.

Name of the Course	PROGRAMMING USING C - LAB		
Course Code	BSAI-151	Credits-3	L-0, T-0, P-6
Lectures to be Delivered	90 Hours of Lab Sessions		
Semester End Examination	**Max Marks: 50**	**Min Pass Marks: 35%**	**Max. Time: 2 hrs**
Internal Assessment (based on Lab work 30%, Lab record 30%, Viva 30%, Attendance 10%)			**Min Marks: 35%** **Max Marks: 25**
Minimum aggregate pass marks should be 40%(35% in each component i.e. semester end examination and IA)			

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Implement the basic structure of C programs.
CO2	Utilize various data types, constants, and operators for data manipulation.
CO3	Apply control flow statements for decision-making and iteration.
CO4	Implement functions, arrays, structures, and file handling for structured programming.

BSAI-151 PROGRAMMING USING C – LAB

Section-1

1) Write a program to demonstrate the basic structure of a C program including comments, preprocessor directives, main function, and return statement.
2) Write a program to demonstrate the declaration and initialization of variables of different data types and also demonstrate the declaration and usage of constants.
3) Write a program to demonstrate the usage of relational, logical, assignment, increment and decrement, conditional, bitwise, and ternary operators.
4) Write a program to check whether the number is even or odd.
5) Write a program to find the largest among three numbers.
6) Write a program to find the grade of a student by using the if-else ladder statement.

Section-2

7) Write a program to implement a basic calculator that performs arithmetic operations using switch statement.
8) Write a program to reverse a given number.
9) Write a program to print the multiplication Table of a number by using do…while loop.
10) Write a program to check whether the given number is prime or not by using for loop.

11) Write a program to find the maximum and minimum elements in an array.
12) Write a program to add two matrices.

Section-3

13) Write a program to create a function to generate the Fibonacci series up to a specified number of terms.
14) Write a program to swap the value of two variables using call by value & by reference.
15) Write a program to define structures and access structure members.
16) Write a program to demonstrate pointer arithmetic by adding and subtracting values from a pointer.
17) Write a program to open, read from, write to, and close a file.

Note:

For Paper Setters: There will be 4 Parts (A, B, C, D) and the examiner shall set 7 questions in total from all the Sections/Blocks (I, II, III) of the syllabus in total. Part A, B, and C will have 2 questions from each Section/Block I, II, III respectively of the syllabus carrying 12 marks each and Part D will have 10 short answer questions from all the Sections/Blocks of the syllabus (I, II, III) carrying 2 marks each.
**Each Section/Block, preferably may have 1-2 units.*
For candidates: Candidates are required to attempt four questions in all selecting one question from each of the sections A, B, & C of the question paper and 7 questions out of 10 questions given in Section D in total carrying 2 marks each. Use of non-programmable calculators is allowed.

Note: The questions papers for any of the lab courses shall not be set by external experts and will be handled at the level of Department in consultation with External Examiner invited for evaluating the lab performances of the students in consultation with the Internal Expert.

Name of the Course	LINUX OPERATING SYSTEM LAB		
Course Code	BSAI-152	Credits-4	L-0, T-0, P-8
Lectures to be Delivered	**120 Hours of Lab Sessions**		
Semester End Examination	**Max Marks: 70**	**Min Pass Marks: 35%**	**Max. Time: 3 hrs**
Internal Assessment (based on Lab work 30%, Lab record 30%, Viva 30%, Attendance 10%)			**Min Marks: 35%** **Max Marks : 30**
Minimum aggregate pass marks should be 40%(35% in each component i.e. semester end examination and IA)			

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Utilize basic linux commands for file manipulation, navigation, and system information retrieval.
CO2	Implement shell scripting concepts to automate tasks and perform conditional branching
CO3	Manage and process text files using commands like cat, sort, cut, and grep.
CO4	Work with file permissions and user accounts using commands and configuration files.

BSAI-152 LINUX OPERATING SYSTEM LAB

Section-1

1. Execute 25 basic commands of LINUX.
2. Basics of functionality and modes of VI Editor.
3. Write a program that accepts user name and reports if user is logged in.
4. Write a program which displays the following menu and executes the option selected by user:
   (I) ls (ii) Pwd 3. ls –l 4. ps –fe
5. Write a program to print 10 9 8 7 6 5 4 3 2 1 .

Section-2

6. Write a program that replaces all "*.txt" file names with "*.txt.old" in the current.
7. Use the cat command to create a file containing data of students. Use tabs to separate the fields, Use the cat command to display the file, Use the sort command to sort the file, and Use the cut and paste commands to swap fields of file. Print the file.
8. Use the appropriate command to determine your login shell and verify it by using /etc/passwd file.
9. Use the 'who' command and redirect the result to a file called myfile1. Use the

more command to see the contents of myfile1.

10. Develop an interactive grep script that asks for a word and a file name and then tells how many lines contain that word.

Section-3

11. Write a program that echoes itself to stdout, but backwards.
12. Write a program that takes a filename as input and checks if it is executable, if not make it executable.
13. Write a program to take string as command line argument and reverse it.
14. Create a data file called employee in the format given below:

a. EmpCode Character

b. EmpName Character
c. Grade Character
d. Years of experience Numeric
e. Basic Pay Numeric

$vi employee

A001	ARJUN	E1	01	12000.00
A006	Anand	E1	01	12450.00
A010	Rajesh	E2	03	14500.00
A002	Mohan	E2	02	13000.00
A005	John	E2	01	14500.00
A009	Denial Smith	E2	04	17500.00
A004	Williams	E1	01	12000.00

15. Perform the following functions on the file:

a. Sort the file on EmpCode.

b. Sort the file on

(i) Decreasing order of basic pay

(ii) Increasing order of years of experience.

c. Display the number of employees whose details are included in the file.

d. Display all records with 'smith' a part of the employee name.

e. Display all records with EmpName starting with 'B'.

f. Display the records on Employees whose grade is E2 and have work experience of 2 to 5 years.

g. Store in 'file 1' the names of all employees whose basic pay is between 10000 and 15000.

h. Display records of all employees who are not in grade E2.

Section-4

16. Write a shell script that accepts a filename, starting and ending line numbers as arguments and displays all the lines between the given line numbers.
17. Write a shell script that deletes all lines containing a specified word in one or more files supplied as arguments to it.
18. Write a shell script that displays a list of all the files in the current directory to which

the user has read, write and execute permissions.

19. Write a shell script that receives any number of file names as arguments, checks if every argument supplied is a file or a directory and reports accordingly. Whenever the argument is a file, the number of lines on it is also reported.
20. Write a shell script that accepts a list of file names as its arguments, counts and reports the occurrence of each word that is present in the first argument file on other argument files.

Note:

For Paper Setters: There will be 5 Parts(A,B,C,D,E) and the examiner shall set 9 questions in total from all the Sections/Blocks(I, II, III, IV) and each question shall carry 14 marks. Part A,B,C, and D will have 2 questions from each Section/Block I, II, III, IV respectively of the syllabus and Part E will have 10 short answer questions from all the Sections/Blocks of the syllabus(I,II,III,IV) carrying 2 marks each.
**Each Section/Block, preferably may have 1-2 units.*
For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and 7 questions out of 10 questions given in Section E in total carrying 2 marks each. Use of non-programmable calculators is allowed.

Note: The questions papers for any of the lab courses shall not be set by external experts and will be handled at the level of Department in consultation with External Examiner invited for evaluating the lab performances of the students in consultation with the Internal Expert.

SEMESTER II

Name of the Course	**Introduction to Data Structures**		
Course Code	BSAI-201	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 70**	**Min Pass Marks: 35%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 15 marks, Tutorials/ Assignments & Presentation 10 marks, Attendance 5 marks)			**Min Marks: 35%** **Max Marks: 30**
Minimum aggregate pass marks should be 40%(35% in each component i.e. semester end examination and IA)			

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	implement basic data structures for operations like traversal, insertion, deletion, and searching.
CO2	Explore sorting algorithms and implement data structures using arrays & linked lists.
CO3	Work with advanced data structures like binary search trees and AVL trees, understanding search, insert, and delete operations.
CO4	Represent and traverse graphs and explore hashing concepts with collision resolution techniques.

INSTRUCTIONS

For Paper Setters: There will be 5 Parts(A,B,C,D,E) and the examiner shall set 9 questions in total from all the Sections/Blocks(I, II, III, IV) and each question shall carry 14 marks. Part A,B,C, and D will have 2 questions from each Section/Block I, II, III, IV respectively of the syllabus and Part E will have 10 short answer questions from all the Sections/Blocks of the syllabus(I,II,III,IV) carrying 2 marks each.

**Each Section/Block, preferably may have 1-2 units.*

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and 7 questions out of 10 questions given in Section E in total carrying 2 marks each. Use of non-programmable calculators is allowed.

BSAI-201 INTRODUCTION TO DATA STRUCTURES

UNIT-I

Introduction to data structures: need and advantages of data structures, types of data structures, data structure operations, array, representation of linear array in memory, linear array operations (traversal, insertion, and deletion), linear and binary search, multi-dimensional arrays. Sorting (bubble sort, insertion sort, selection sort, merge sort, and quick sort).

Linked list: introduction, representation of linked list in memory, operations on linked list (Traversal, searching, insertion, deletion), circular linked list, doubly linked list.

UNIT-II

Stack: introduction, stack representation in memory, stack operations (Traversal, insertion, deletion). Stack implementation using array and linked list. Application of stacks (converting arithmetic expression from infix notation to polish notations and their subsequent evaluation, recursion).

Queue: introduction, representation in memory, Operations on Queues, queue implementation using array and linked list, Circular Queues, Dequeue, Priority Queues.

UNIT-III

Trees: Introduction, binary trees, representing binary trees in memory, traversing binary trees (Inorder, preorder, postorder), binary search tree, binary search tree operations(search, insert, delete), AVL tree, insertion and deletion in AVL tree.

UNIT-IV

Graphs: introduction, basic terminologies, representation- adjacency matrix and linked representation, traversing- depth-first search, breadth-first search.

Hashing: introduction, hash function, collision resolution: open addressing-linear probing, chaining.

Textbook:

1. Seymour Lipschutz, “Data Structures”, McGraw Hill Education, Revised edition, 2014.

Reference Books:

1. Reema Thareja, “Data Structures Using C”, Oxford University Press, 2nd edition, 2014.
2. Yashavant Kanetkar, “Data Structures through C” BPB Publication, 5th edition, 2023.
3. Ellis Horowitz, Sartaj Sahni, and Susan Anderson-Freed, “Fundamentals of Data Structures in C”, Universities Press, 2nd edition, 2008.
4. Vishal Goyal, Lalit Goyal, Pawan Kumar, “ A simplified approach to Data Structures”, Shroff Publishers, 2014.

Name of the Course	DATABASE MANAGEMENT SYSTEM (DBMS)		
Course Code	BSAI-202	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 70**	**Min Pass Marks: 35%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 15 marks, Tutorials/ Assignments & Presentation 10 marks, Attendance 5 marks)			**Min Marks: 35%** **Max Marks: 30**
Minimum aggregate pass marks should be 40%(35% in each component i.e. semester end examination and IA)			

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the fundamental concepts of database management systems (DBMS) and their advantages.
CO2	Apply data modeling techniques, including the Entity-Relationship (ER) model and normalization, to design efficient databases.
CO3	Utilize Structured Query Language (SQL) for data retrieval, manipulation, and definition.
CO4	Explain transaction management concepts, concurrency control methods, and database performance tuning strategies.

INSTRUCTIONS

For Paper Setters: There will be 5 Parts(A,B,C,D,E) and the examiner shall set 9 questions in total from all the Sections/Blocks(I, II, III, IV) and each question shall carry 14 marks. Part A,B,C, and D will have 2 questions from each Section/Block I, II, III, IV respectively of the syllabus and Part E will have 10 short answer questions from all the Sections/Blocks of the syllabus(I,II,III,IV) carrying 2 marks each.

**Each Section/Block, preferably may have 1-2 units.*

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and 7 questions out of 10 questions given in Section E in total carrying 2 marks each. Use of non-programmable calculators is allowed.

BSAI-202 Database Management System

UNIT-I

Introduction & DBMS Architecture: Data versus Information, Introducing the Database, Role and Advantages of the DBMS, Types of Databases, Database Design Importance, Evolution of File System Data Processing, Problems with File System, Data Processing, Database Systems.

Data Models – Data Modeling and Data Models, The Importance of Data Models, Data Model Basic Building Blocks, Business Rules, The Evolution of Data Models, Degrees of Data Abstraction

Entity Relationship Model: Entities, attributes, Relationships, Connectivity and Cardinality, Existence Dependence, Relationship Strength, Weak Entities, Relationship Participation, Relationship Degree, Recursive Relationships, Associative (Composite) Entities, Developing an ER Diagram, Database Design Challenges: Conflicting Goals.

UNIT-II

Advanced Data Modeling: The Extended Entity Relationship Model, Entity Clustering, Entity Integrity: Selecting Primary Keys, Design Cases: Learning Flexible Database Design.

Normalization of Database Tables: Database Tables and Normalization, The Need for Normalization, The Normalization Process, Improving the Design, Surrogate Key Considerations, Higher- Level Normal Forms, Normalization and Database Design, Denormalization, Data-Modeling Checklist.

UNIT-III

Structured Query Language (SQL): Introduction to SQL, Basic SELECT Queries, SELECT Statement Options, FROM Clause Options, ORDER BY Clause Options, WHERE Clause Options,

Aggregate Processing, Subqueries, SQL Functions, Relational Set Operators, Crafting SELECT Queries.

Advanced SQL: Data Definition Commands, Creating Table Structures, Altering Table Structures, Data Manipulation Commands, Virtual Tables: Creating a View, Sequences, Procedural SQL, Embedded SQL Database Design: The Information System, The Systems Development Life Cycle, The Database Life Cycle, Conceptual Design, DBMS Software Selection, Logical Design, Physical Design, Database Design Strategies, Centralized versus Decentralized Design .

UNIT-IV

Transaction Management and Concurrency Control: Transaction, Concurrency Control with Locking Methods, Concurrency Control with Time Stamping Methods, Concurrency Control with Optimistic Methods, ANSI Levels of Transaction Isolation, Database Recovery Management ,Database Administration and Security.

Text Books:

1. Elmasri Ramez and Navathe Shamkant B, "Fundamentals of Database Systems", Pearson Education, 7th Edition, 2016.

Reference Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw Hill, 7th Edition, 2019.
2. Joel Murach, "Murach's MySQL", Murach, 3rd Edition, 2022.
3. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", McGraw-Hill, 4th Edition, 2022.

Name of the Course	PROBABILITY AND STATISTICS		
Course Code	BSAI-203	Credits-3	L-3, T-0, P-0
Lectures to be Delivered	45 (1 Hr Each) (L=45, T=0 for each semester)		
Semester End Examination	**Max Marks: 50**	**Min Pass Marks: 35%**	**Max. Time: 2 hrs**
Internal Assessment (based on sessional test (2) 10 marks, Tutorials/ Assignments & Presentation 10 marks, Attendance 5 marks)			**Min Marks: 35%** **Max Marks: 25**
Minimum aggregate pass marks should be 40%(35% in each component i.e. semester end examination and IA)			

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Apply probability concepts and analyze data using statistical measures.
CO2	Model real-world phenomena using appropriate probability distributions.
CO3	Distinguish data types, calculate key statistics, and assess data normality.
CO4	Conduct hypothesis testing and analyze variance to draw data conclusions.

INSTRUCTIONS

For Paper Setters: There will be 4 Parts (A, B, C, D) and the examiner shall set 7 questions in total from all the Sections/Blocks (I, II, III) of the syllabus in total. Part A, B, and C will have 2 questions from each Section/Block I, II, III respectively of the syllabus carrying 12 marks each and Part D will have 10 short answer questions from all the Sections/Blocks of the syllabus (I, II, III) carrying 2 marks each.

**Each Section/Block, preferably may have 1-2 units.*

For candidates: Candidates are required to attempt four questions in all selecting one question from each of the sections A, B, & C of the question paper and 7 questions out of 10 questions given in Section D in total carrying 2 marks each. Use of non-programmable calculators is allowed.

BSAI-203 PROBABILITY AND STATISTICS

UNIT-I

Probability: Define probability, Random experiment, outcome, trial and event, Exhaustive events, favorable events, mutually exclusive events, marginal, sample space, definition of probability, addition theorem of probability, conditional probability, joint probability, independent events, Mutually and pair wise independent events, Theorems on Addition and Multiplication of probabilities, Baye's theorem and its applications.

Random Variable & Distribution Functions: Random Variables, Distribution Function, Discrete random variable, continuous random variable, Probability mass function (pmf), Probability density function (pdf), and their properties, cumulative distribution function and its properties, Expectation and variance of a random variable and its properties.

UNIT-II

Introduction to Statistics: Primary and Secondary data , Nominal, Ordinal, Ratio, and Interval scale (with examples) - Graphical Representation of data : Bar-charts, Pie-diagrams, Histograms, Frequency polygon, Ogives.

Measures of Central Tendency: properties ,merits and demerits ,weighted means, graphical location of median, quartiles, deciles, percentiles, and mode , relation between arithmetic mean, geometric mean and harmonic mean.

UNIT-III

Measures of dispersion: – characteristics , Coefficient of dispersion , Coefficient of variation – Moments – Relation between moments about mean in terms of moments about point , Pearson's coefficients.

Skewness and Kurtosis : Pearson's coefficient of skewness , Bowley's coefficient of Skewness , coefficient of Skewness based upon moments. Curve fitting , Principle of least squares , Fitting of straight line, parabola, exponential and power curve.

Textbooks:

1. Gupta, S.C. and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons,New Delhi, 12th edition, 2020.
2. S.P. Gupta, Statistical Methods, Sultan Chand & Sons, New Delhi, 46th Edition, 2021.

Reference Books:

1. T. Veerarajan, Probability, Statistics and Random Processes, McGraw-Hill Education India, 4th edition, 2018.
2. Allan Bluman, Elementary Statistics: A Step By Step Approach, McGraw-Hill Higher Education, 2014.
3. Agarwal B.L., Basic Statistics, New Age International Pvt. Ltd. , 7th edition, 2022.

Name of the Course	DATA STRUCTURE USING C LAB		
Course Code	BSAI-251	Credits-3	L-0, T-0, P-6
Lectures to be Delivered	**90 Hours of Lab Sessions**		
Semester End Examination	**Max Marks: 50**	**Min Pass Marks: 35%**	**Max. Time: 2 hrs**
Internal Assessment (based on Lab work 30%, Lab record 30%, Viva 30%, Attendance 10%)			**Min Marks: 35% Max Marks: 25**
Minimum aggregate pass marks should be 40%(35% in each component i.e. semester end examination and IA)			

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Apply fundamental array operations.
CO2	Implement various sorting algorithms.
CO3	Design programs using linear and binary search for efficient retrieval.
CO4	Utilize stacks, queues, and linked lists for data structures and operations.

BSAI-251 DATA STRUCTURE USING C LAB

Section-1

1) Write a program to add an element from a given array.
2) Write a program to delete an element from a given array.
3) Write a program to implement linear search.
4) Write a program to implement Binary search.
5) Write a program to implement bubble sort.

Section-2

6) Write a program to implement selection sort.
7) Write a program to implement insertion sort.
8) Write a program to multiply two matrices.
9) Create a linked list with n nodes.
10) Write a program to find the largest element in the linked list.

Section-3

11) Implement stack using array and linked list.
12) Write a program to reverse a string using stack.
13) Implement queue using array and linked list.

14) Write a program to implement a circular queue.
15) Write a program to implement queue using the stack data structure.

Note:

For Paper Setters: There will be 4 Parts (A, B, C, D) and the examiner shall set 7 questions in total from all the Sections/Blocks (I, II, III) of the syllabus in total. Part A, B, and C will have 2 questions from each Section/Block I, II, III respectively of the syllabus carrying 12 marks each and Part D will have 10 short answer questions from all the Sections/Blocks of the syllabus (I, II, III) carrying 2 marks each.
**Each Section/Block, preferably may have 1-2 units.*
For candidates: Candidates are required to attempt four questions in all selecting one question from each of the sections A, B, & C of the question paper and 7 questions out of 10 questions given in Section D in total carrying 2 marks each. Use of non-programmable calculators is allowed.

Note: The questions papers for any of the lab courses shall not be set by external experts and will be handled at the level of Department in consultation with External Examiner invited for evaluating the lab performances of the students in consultation with the Internal Expert.

Name of the Course	DATABASE MANAGEMENT SYSTEM (DBMS) LAB		
Course Code	BSAI-252	Credits-4	L-0, T-0, P-8
Lectures to be Delivered	**120 Hours of Lab Sessions**		
Semester End Examination	**Max Marks: 70**	**Min Pass Marks: 35%**	**Max. Time: 3 hrs**
Internal Assessment (based on Lab work 30%, Lab record 30%, Viva 30%, Attendance 10%)			**Min Marks: 35%** **Max Marks: 30**
Minimum aggregate pass marks should be 40%(35% in each component i.e. semester end examination and IA)			

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Design and manage relational databases using SQL.
CO2	Implement normalized database schemas for real-world applications.
CO3	Utilize advanced SQL features for efficient data access.
CO4	Explore NOSQL databases and data warehousing concepts for diverse data needs.

BSAI-252 DATABASE MANAGEMENT SYSTEM- LAB

Section-1

1. Create a basic database and explore the SQL syntax for creating tables, inserting data, and performing simple queries.
2. Write SQL queries to filter data based on specific conditions, sort results, and use aggregate functions like COUNT, SUM, and AVG.
3. Combine data from multiple tables using different types of joins (inner, outer, cross, and self-joins). Implement subqueries and nested queries.
4. Design a database schema for a real-world scenario (e.g., an e-commerce application, a university management system) adhering to normalization principles.

Section-2

5. Create tables, define constraints (primary keys, foreign keys, and other constraints), and perform data manipulation operations (INSERT, UPDATE, DELETE) using SQL.
6. Create views to simplify complex queries and develop stored procedures to encapsulate business logic.

7. Explore transaction management, ACID properties, and concurrency control mechanisms (locking, timestamps, etc.) using appropriate scenarios.
8. Implement indexing strategies for improving query performance and analyze execution plans to optimize queries.

Section-3

9. Explore MongoDB, a popular NoSQL database. Create collections, insert documents, and perform querying and aggregation operations.
10. Learn about Redis, an in-memory data structure store. Implement caching mechanisms and data structures like strings, hashes, lists, and sets using Redis.
11. Design and implement a data warehouse schema (star or snowflake) and perform Online Analytical Processing (OLAP) operations using SQL or specialized tools like Microsoft Analysis Services.
12. Develop an ETL process to extract data from various sources, transform it according to business rules, and load it into a data warehouse or staging area.

Section-4

13. Implement database security measures like user authentication, access control, and data encryption. Explore database auditing and monitoring techniques.
14. Explore distributed database systems like Apache Cassandra or HBase. Understand the challenges and techniques involved in managing and querying large-scale data.
15. Perform database administration tasks like backup and recovery, performance tuning, and monitoring using appropriate tools and techniques.
16. Implement a Data Replication and Sharding Strategy for a Distributed Databases.

Note:

For Paper Setters: There will be 5 Parts(A,B,C,D,E) and the examiner shall set 9 questions in total from all the Sections/Blocks(I, II, III, IV) and each question shall carry 14 marks. Part A,B,C, and D will have 2 questions from each Section/Block I, II, III, IV respectively of the syllabus and Part E will have 10 short answer questions from all the Sections/Blocks of the syllabus(I,II,III,IV) carrying 2 marks each.
**Each Section/Block, preferably may have 1-2 units.*
For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and 7 questions out of 10 questions given in Section E in total carrying 2 marks each. Use of non-programmable calculators is allowed.

Note: The questions papers for any of the lab courses shall not be set by external experts and will be handled at the level of Department in consultation with External Examiner invited for evaluating the lab performances of the students in consultation with the Internal Expert.