Curriculum of Diploma Programme

in

Artificial Intelligence & Machine Learning

Department of Science, Technology and Technical Education (DSTTE), State Govt. of Bihar

State Board of Technical Education (SBTE), Bihar

Semester – III
Teaching & Learning Scheme

Course Codes	Category of course	Course Titles	Teaching & Learning Scheme (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
2418301	**BCC**	**Data Structures and Algorithms** (AIML, CSE)	03	-	04	02	09	06
2444302	**PCC**	**Digital System and Computer Organization**	02	01	-	02	05	04
2444303	**PCC**	**Introduction to Internet of Things**	03	-	04	02	09	06
2444304	**PCC**	**Data Base Management System** (CSE, AIML)	03	-	04	02	09	06
2400305	**PCC**	**Mathematics** (Probability and Statistics)	02	01	-	02	05	04
2444306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	02	02	04	02
2400107	**NRC**	**Professional Ethics** (CE, CSE, ELX, ELX (R), FTS, ME, AIML, MIE, CHE, CRE, FPP, GT, EE, AE, CACDDM)	01	-	-	-	01	01
2400008	**NRC**	**Sports, Yoga and Meditation** (Common for All Programmes)	-	-	01	01	02	01
Total			**14**	**2**	**15**	**13**	**44**	**30**

Note: Prefix will be added to course code if applicable (T for Theory Paper, P for Practical Paper and S for Term Work)

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

Semester - III
Assessment Scheme

Course Codes	Category of course	Course Titles	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2418301	**BCC**	**Data Structures and Algorithms** (AIML, CSE)	30	70	20	30	20	30	200
2444302	**PCC**	**Digital System and Computer Organization**	30	70	20	30	-	-	150
2444303	**PCC**	**Introduction to Internet of Things**	30	70	20	30	20	30	200
2444304	**PCC**	**Data Base Management System** (CSE, AIML)	30	70	20	30	20	30	200
2400305	**PCC**	**Mathematics** (Probability and Statistics)	30	70	20	30	-	-	150
2444306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	**-**	**-**	10	15	10	15	50
2400107	**NRC**	**Professional Ethics**	**25**	**-**	-	-	-	-	25
2400008	**NRC**	**Sports, Yoga and Meditation** (Common for All Programmes)	-	-	10	-	06	09	25
Total			**175**	**350**	**120**	**165**	**76**	**114**	**1000**

Note: Prefix will be added to course code if applicable (T for Theory Paper, P for Practical Paper and S for Term Work)

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external **Note:**

A) Course Code : **2418301(T2418301/P2418301/S2418301)**

B) Course Title : Data Structures and Algorithm (AIML, CSE)

C) Pre- requisite Course(s) : Programming with C

D) Rationale :

Data structures are ways of organizing and storing data to be accessed and manipulated efficiently. An algorithm is a set of instructions or procedures designed to solve a particular problem or accomplish a specific task. Selecting the appropriate data structures optimizes the performance of algorithms that operate on that data.

This course fosters students to select appropriate data structures and algorithms for a given problem so as to optimize the performance of the program and improve its overall efficiency.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Analyze the efficiency of algorithm

CO-2 Implement operations on linear data structures

CO-3 Implement operations on non-linear data structures

CO-4 Apply different searching, sorting and hashing techniques to solve real world problems.

CO-5 Design efficient algorithms to solve the real-world problems.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	1	-	-	-	-	-	1		
CO-2	2	2	1	1	-	-	-		
CO-3	2	2	1	1	-	-	-		
CO-4	2	3	1	1	-	-	-		
CO-5	2	3	1	1	-	-	1		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2418301	Data Structures and Algorithm	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

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C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2418301	Data Structures and Algorithm	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done internally (40%) as well as externally (60%). Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2418301

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe different data types in data structure. *TSO 1b.* Classify the types of data structure based on its characteristics *TSO 1c.* Calculate the complexity of a given algorithm in terms of time and space. *TSO 1d.* Determine the running time of an algorithm using the given notation *TSO 1e.* Determine the time complexity of recursive algorithm	**Unit-1.0 Fundamentals of Algorithms and its Analysis** 1.1. Data Types System defines data types, User defined data types 1.2. Basic concept of data structure Linear data structure, Non-linear data structure , Abstract data types 1.3. Algorithm and its analysis - Introduction of algorithm, Runtime analysis of algorithm, Space Complexity of algorithm, Worst case analysis, Best case analysis, Average case analysis 1.4. Asymptotic Notation Big-O Notation, Omega- Ω Notation, Theta Notation 1.5 Time complexity of recursive algorithm Basic concept of recursion, Time complexity analysis using Master theorem	**CO-1**
TSO 2a. Create resizable arrays TSO 2b. Implement basic operations on arrays and string TSO 2c. Create linked lists that can dynamically allocate and deallocate memory TSO 2d. Identify the different types of Linked List TSO 2e. Implement basic operations on linked lists, such as insertion, deletion, and traversal. TSO 2f. Evaluate postfix and infix expression TSO 2g. Implement basic operation on stack such as insertion, deletion, and traversal TSO 2h. Implement basic operations on queue, such as insertion, deletion, and traversal. TSO 2i. Explain the use of Queue data structure for real-world problems. TSO 2j. Implement enqueue and dequeue operations	**Unit 2.0 Linear Data Structures** 2.1 Array and String Concept of arrays, Single and Multi-dimensional arrays, Dynamic arrays, Array operations, Time and space complexity of array operations, Introduction to string, String manipulation 2.2 Linked List Introduction to linked list, Singly Linked List, circular Linked List, Basic operation on Linked List: Traversing List, Insertion, deletion, and modification in Linked List 2.3 Stacks and Queue Introduction to Stack, Stack operations, Implementation of Stack using simple array, dynamic array, and Linked List, Application of stack for evaluating Infix or Postfix Expression, balancing the symbols, function calls, Introduction to Queue, Queue operations, Implementation of Queue using simple array, dynamic array, and Linked List, Application of Queue	**CO-2**
TSO 3a. Create Binary search tree (BST) for given data set TSO 3b. Find minimum/maximum or k^{th}- smallest element in tree TSO 3c. Performs different traversal order of tree TSO 3d. Create a heap(min/max) for given array data	**Unit 3.0 Non-linear Data Structure** 3.1 Tree - Basic terminologies: tree, Degree of a node, Degree of tree, level of node, Depth/height of tree, In-degree, Out-degree, Path, Ancestor & Descendent node - Types of trees: Binary Tree, Binary Search tree (BST), Balance tree, B-tree - Traversal of Binary tree: In order, pred order, post order traversal 3.2 Priority Queue and Heaps	**CO-3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3e. Perform different operation on heap such as insertion and deletion of an element, TSO 3f. Represent the given graph using: Adjacency Matrix, Adjacency List, and Adjacency Set TSO 3g. Perform graphs traversal using different methods TSO 3h. Find shortest path in various types of graphs TSO 3i. Evaluate minimum spanning tree of a graph using given algorithm	- Introduction to priority queue, Different operations in priority queue, Implementation of priority queue using BST - Basics of Min heap, Max heap, and Binary heap, Basic operation on Binary heap, Heapifying the elements of binary heap 3.3 Graphs - Basics terminologies: Vertex and edge of graph, weighted and unweighted Graph, directed and undirected graph, Degree, in-degree and out-degree of a node (vertex), Articulation point - Graph representation: Adjacency Matrix, Adjacency List, Adjacency Set - Graph Traversal: BFS, DFS - Shortest Path in unweighted, weighted, and negative edge graph, Shortest Path algorithm in weighted graph [Dijkstra's], Shortest Path algorithm in negative edge graph [Bellman-Ford Algorithm] - Shortest Path algorithm in weighted directed graph [Floyd-Warshall algorithm] - Spanning tree in graph, Minimum Spanning tree algorithm: Prim's algorithm, Kruskal's algorithm	
TSO 4a. Develop algorithm for sorting a given dataset using the specified sorting method. TSO 4b. Explain the working of given searching method with an example TSO 4c. Develop an algorithm for searching an element a using binary search technique. TSO 4d. Perform basic operations of Hash Table TSO 4e. Apply Hash Tables to various data structures such as arrays, linked lists	**Unit 4.0 Sorting and Searching Techniques** 4.1 Sorting techniques: - bubble sort, selection sort, insertion sort, quicksort, merge sort 4.2 Searching techniques: Linear search, Binary search 4.3 Hash Table Introduction to Hash Table, Hash Function, Hash Collision resolution Techniques: Direct chaining, Open addressing	**CO-4**
TSO 5a. Apply Huffman coding algorithm for solving real world problems TSO 5b. Apply divide and conquer techniques to solve a problem TSO 5c. Explain the features of dynamic programming approaches TSO 5d. Find shortest path of a given graph using dynamic algorithm TSO 5e. Find longest common subsequence from given strings	**Unit 5.0 Algorithm Design Techniques** 5.1 Element of Greedy algorithm - Greedy choice property, Optimal substructure - Huffman coding algorithm 5.2 Divide and Conquer Techniques - Divide and Conquer Visualization 5.3 Dynamic Programming Approaches - Top-down and button-up Dynamic programming - Basics of Overlapping subproblem and Memorization techniques 5.4 Dynamic Programming Problem Longest common subsequence, Knapsack problem, Matrix chain multiplication	**CO-5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2418301

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Find size of different data types	1.	a. Write Program to find size of different data types.	CO-1
LSO 2.1. Implement insertion and deletion operation on array. *LSO 2.2.* Implement different operations on given strings. *LSO 2.3.* Apply insertion, deletion, traversing over a singly linked list. *LSO 2.4.* Implement insertion, deletion, traversing over a circular linked list. *LSO 2.5.* Create stack using array and linked list *LSO 2.6.* Implement stack for the evaluation of given expression *LSO 2.7.* Implement enqueue and dequeue operations on Queue using array and linked list	2.	a. Write a program to insert an element in a given array. b. Write a program to delete an element from a given array c. Write a program to modify a character in a string d. Write a program to insert a node at beginning, mid, and end of a given singly linked list e. Write a program to insert a node at beginning, mid, and end of a given circular linked list f. Write a program using stack for a given expression evaluation. g. Write a program to perform enqueue and dequeue operations on Queue	CO-2
LSO 3.1. Develop program to create a tree *LSO 3.2.* Develop program to perform traversal operations on a given tree. *LSO 3.3.* Create a priority queue using heap *LSO 3.4.* Create a priority queue using BST *LSO 3.5.* Perform the following operations on the heap: a. Insert an element into the heap. b. Delete the root element (highest priority) from the heap. c. Retrieve the root element without removing it. d. Check if the heap is empty *LSO 3.6.* Develop program to perform following operation on a given Priority Queue: a. Enqueue of an element b. Dequeue of an element c. Find the element with highest priority d. Determine the size of Priority Queue e. Empty check of Priority Queue *LSO 3.7.* Develop program to detect a cycle in a given graph using DFS *LSO 3.8.* Develop program to find an articulation point in a given undirected graph.	3.	a. Write programs to perform in order pre order, and post order traversal on a tree. b. Write functions to perform the following operations on the heap: i. Insert an element into the heap. ii. Delete the root element (highest priority) from the heap. iii. Retrieve the root element without removing it. iv. Check if the heap is empty c. Write a program to perform following operation on a given Priority Queue: i. Enqueue of an element ii. Dequeue of an element iii. Find the element with highest priority iv. Determine the size of Priority Queue v. Empty check of Priority Queue d. Write programs to perform following operation on graph i. To detect a cycle in a given graph using DFS ii. To find an articulation point in a graph using DFS iii. To find the shortest path between two given nodes using BFS	CO-3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
		e. Apply Bellman-Ford algorithm to find shortest path for a given negative edge graph. f. Apply Floyd-Warshall algorithm to find shortest path for a given weighted directed graph.	
LSO 4.1. Apply an insertion sort, selection sort, and bubble sort on a given unsorted array. *LSO 4.2.* Implement a quick sort on a given unsorted array. *LSO 4.3.* Implement a merge sort on a given unsorted array. *LSO 4.4.* Apply a counting sort on a given list of elements *LSO 4.5.* Write the steps to separate even and odd numbers for given array. *LSO 4.6.* Apply a binary search to search an element *LSO 4.7.* Write program to search an element which appears maximum number of times in given array. *LSO 4.8.* Create hash table data structure using array data structure. *LSO 4.9.* Perform the following operations on the hash table: a. Insert a key-value pair into the hash table. b. Retrieve the value associated with a given key from the hash table. c. Delete a key-value pair from the hash table. d. Check if a key exists in the hash table.	4	a. Develop a Program to: i. Apply insertion sort, quicksort, and merge sort on given dataset. ii. Apply binary search to find an element in given array. b. Write a program to create a hash table using array data structure. c. Write a program to perform the following operations on the hash table: i. Insert a key-value pair into the hash table. ii. Retrieve the value associated with a given key from the hash table. iii. Delete a key-value pair from the hash table. iv. Check if a key exists in the hash table.	CO-4
LSO 5.1. Find Longest common sequence in given string *LSO 5.2.* Find shortest path using Bellman-Ford algorithm for a given graph *LSO 5.3.* Apply divide and conquer method Find minimum and maximum value from a list of elements using.	5.	Develop Program to: i. Find Longest common sequence in given strings. ii. Find shortest path using Bellman-Ford algorithm for a given graph. iii. Find minimum and maximum value from n elements using divide and conquer method.	CO-5

L) Suggested Term Work and Self Learning: S2418301 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Build a phonebook application that stores contacts using doubly linked list.
2. Implement an algorithm to solve a Sudoku puzzle.
3. Build a spell checker that suggests corrections for misspelled words
4. Implement the Huffman coding algorithm to compress and decompress text files
5. Create a calculator that uses a stack data structure to evaluate expressions.

c. Seminar topics:

1. Scope of Data Structure and Algorithm in real world.
2. Height balance tree
3. Comparative analysis of given sorting methods

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use the appropriate assessment strategy and its weightage in theory, laboratory and Term work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	20%	20%	5%	5%
CO-2	20%	20%	20%	20%	20%	20%	20%
CO-3	25%	25%	25%	20%	20%	25%	25%
CO-4	20%	20%	20%	20%	20%	25%	25%
CO-5	20%	20%	20%	20%	20%	25%	25%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Fundamentals of algorithms and its analysis	8	CO-1	10	3	3	4
Unit 2.0 Linear Data Structures	10	CO-2	14	4	4	6
Unit 3.0 Non-linear data structure	10	CO-3 and CO-4	18	5	3	10
Unit 4.0 Sorting and Searching Techniques	12	CO-5	14	4	3	7
Unit 5.0 Algorithm Design Techniques	8	CO-6	14	4	4	6
Total	**48**	**-**	**70**	**20**	**17**	**33**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Write Program to find size of different data types.	CO-1	30	60	10
2.	a. Write a program to insert an element in a given array. b. Write a program to delete an element from a given array c. Write a program to modify a character in a string d. Write a program to insert a node at beginning, mid, and end of a given singly linked list e. Write a program to insert a node at beginning, mid, and end of a given circular linked list f. Write a program using stack for a given expression evaluation. g. Write a program to perform enqueue and dequeue operations on Queue.	CO-2	30	60	10
3.	a. Write programs to perform in order pre order, and post order traversal on a tree. b. Write functions to perform the following operations on the heap: i. Insert an element into the heap. ii. Delete the root element (highest priority) from the heap. iii. Retrieve the root element without removing it. iv. Check if the heap is empty c. Write a program to perform following operation on a given Priority Queue: i. Enqueue of an element ii. Dequeue of an element iii. Find the element with highest priority iv. Determine the size of Priority Queue v. Empty check of Priority Queue d. Write programs to perform following operation on graph i. To detect a cycle in a given graph using DFS ii. To find an articulation point in a graph using DFS iii. To find the shortest path between two given nodes using BFS e. Apply Bellman-Ford algorithm to find shortest path for a given negative edge graph. f. Apply Floyd-Warshall algorithm to find shortest path for a given weighted directed graph.	CO-3	30	60	10
4.	a. Develop a Program to: i. Apply insertion sort, quicksort, and merge sort on given dataset. ii. Apply binary search to find an element in given array. b. Write a program to create a hash table using array data structure.	CO-4	30	60	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
	c. Write a program to perform the following operations on the hash table: i. Insert a key-value pair into the hash table. ii. Retrieve the value associated with a given key from the hash table. iii. Delete a key-value pair from the hash table. iv. Check if a key exists in the hash table.				
5.	Develop Program to: i. Find Longest common sequence in given strings. ii. Find shortest path using Bellman-Ford algorithm for a given graph. iii. Find minimum and maximum value from n elements using divide and conquer method.	CO-5	30	60	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad **Specifications** (No Generic) Give basic configuration or Latest	Relevant Experiment/Practical Number
1	Computer System	Any General-purpose Computer	1 to 5
2	Complier	Turbo C/ Dev C/any other C programming language complier.	1 to 5

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Data Structures Using C	Reema thareja	Oxford university press INDIA ISBN-10 : 0198099304, ISBN-13 : 978-0198099307
2	Introduction to Algorithms	Thomas H. Cormen.	The MIT Press, ISBN-10 : 9780262033848 ISBN-13 : 978-0262033848
2	Algorithms in C	Robert Sedgewick	Pearson Education, ISBN-10 : 0201314525 ISBN-13 : 978-0201314526
3	Data Structures and Algorithms in C	Mark Allen Weiss	Pearson Education, second edition ISBN-10 : 8177583581, ISBN-13 : 978-8131714744

(b) Online Educational Resources:

1. https://www.geeksforgeeks.org/data-structures/
2. https://www.programiz.com/dsa
3. https://www.freecodecamp.org/news/tag/data-structures/
4. https://www.w3schools.in/data-structures/intro

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Lab Manuals

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A) Course Code **: 2444302(T2444302/S2444302)**

B) Course Title **:** Digital System and Computer Organization

C) Pre- requisite Course(s) **:** Fundamentals of IT

D) Rationale **:**

Digital systems are designed to store, process, and communicate information in digital form. They are found in a wide range of applications, including process control, communication systems, digital instruments, and consumer products. Computer Organization lets you know how exactly each instruction is executed at the micro level. For the study of embedded systems/ processor design, these concepts are very important, as they form the basis of design strategy.

This paper enables students to acquire basic knowledge and skills of working with logic gates, combinational and sequential logic circuits using discrete gates as well as digital ICs which will allow the diploma students to interpret the working of digital equipment and comprehension of the hardware/ software interface which in turn is useful in embedded and mobile computing, high performance game programming etc.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Interpret the working of digital system using number system and codes.

CO-2 Implement logic circuits using Boolean expression.

CO-3 Design simple Sequential and combinational circuits.

CO-4 Illustrate the working of CPU and its operations.

CO-5 Illustrate the memory and I/O architecture of the computer system.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	1	-	-	-	-	-	-		
CO-2	2	2	1	1	-	-	1		
CO-3	2	2	2	1	-	-	-		
CO-4	2	1	1	1	-	-	1		
CO-5	2	1	-	1	-	-	-		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2444302	Digital System and Computer Organization	02	01	-	02	05	04

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2444302	Digital System and Computer Organization	30	70	20	30	-	-	150

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done internally (40%) as well as externally (60%). Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2444302

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Convert a number from one system to another system. *TSO 1b.* Perform binary arithmetic operation on two different binary numbers. *TSO 1c.* Convert a binary number into its 1's and 2's complements *TSO 1d.* Convert the given coded number into another coded system. *TSO 1e.* Add the two decimal numbers using BCD coded system.	**Unit 1.0: Basic Structure of Computers and Number System:** 1.1 Introduction to number system, base or radix of number system, binary, octal, decimal, and hexadecimal number system 1.2 Arithmetic operation on binary system- Addition, subtraction, multiplication and division 1.3 Conversion from one system to another, 1's and 2's complements, 1.4 Codes: BCD, Gray code, Excess-3 and ASCII code 1.5 BCD arithmetic: BCD addition	**CO-1**
TSO 2a. Develop the basic gates using the given NAND/NOR gate as universal gate. TSO 2b. Simplify the given expression using Boolean laws. TSO 2c. Develop logic circuits using given Boolean expressions. TSO 2d. Compare the salient characteristics of the given digital logic families. TSO 2e. Develop a standard SOP/POS logic circuit for a given logical expression. TSO 2f. Minimize a given expression using K-map	**Unit 2.0 Basic of Gates and Boolean Algebra:** 2.1 Introduction to logic gates: truth table of basic logic gates (AND, OR, NOT), Universal gates (NAND and NOR) and Special purpose gates (EX- OR, EX-NOR) 2.2 Boolean algebra: Laws of Boolean algebra, Duality Theorem, De-Morgan's theorems 2.3 Standard Boolean representation: Sum of Product (SOP) and Product of Sum (POS), Min-term and Max-term, conversion between SOP and POS forms, realization using NAND /NOR gates 2.4 K-map reduction technique for the Boolean expression: Minimization of Boolean functions up to 4 variables (SOP and POS form)	**CO-2**
TSO 3a. Draw the circuit diagram of half and full adder. TSO 3b. Draw the circuit diagram of half and full Subtractor. TSO 3c. Design a octal to binary encoder. TSO 3d. Design a binary to octal decoder. TSO 3e. Design Multiplexer for a given input. TSO 3f. Design Demultiplexer for a given input. TSO 3g. Use given flip-flop to construct specific counter.	**Unit3.0: Sequential and Combinational Circuits** 3.1 Adders: Half Adder, Full Adder 3.2 Subtractors: Half sub tractor, Full subtractor 3.3 Encoder, Decoder 3.4 Multiplexer, Demultiplexer 3.5 Flip Flops- RS, T, D, JK, Master/ Slave JK 3.6 Synchronous/Asynchronous counter- Ripple, decade counter	**CO-3**
TSO 4a. Describe the micro operation of the CPU. TSO 4b. Explain the process of Control unit in the context of processing of the instruction and data. TSO 4c. Explain the roles of different components of CPU. TSO 4d. Explain the concept of addressing	**Unit 4.0 Central Processing Unit and Instruction:** 4.1 Micro operations: Arithmetic micro-operations, Logic micro-operations, Shift micro-operations 4.2 Control Unit: Performing an Arithmetic or Logic operation, fetching a word from memory, storing a word in a memory, Execution of a complete Instruction, Hardwired Control Unit, Micro programmed Control Unit.	**CO-4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
modes used in the computer. TSO 4e. Describe the instruction types and cycles used in the computer system.	4.3 Components of CPU: Buses, Registers, Flags, Stacks, I/O Ports 4.4 General Register Organization, Types of Instructions, Instruction formats, Addressing modes, Data transfer and manipulation, Program control, Instruction cycle.	
TSO 5a. Explain the characteristics of the memory system. TSO 5b. Differentiate between the Static & Dynamic memories. TSO 5c. Explain the need of different types of memory. TSO 5d. Explain the role of interrupts.	**Unit 5.0 Memory and I/O Organization:** 5.1 Characteristics of Memory system, Types of memories, Main memory, Static & Dynamic memories, Secondary memory, Cache memory, Virtual memory 5.2 Peripheral Devices, Input-output Interface, Interrupt Handling, Types of Interrupts 5.3 Direct Memory Access, Input-output Processor (IOP), Synchronous and Asynchronous Data Transfer.	**CO-5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: (Not Applicable)

L) Suggested Term Work and Self Learning: S2444302 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted Cos.

b. Micro Projects:

1. Prepare a market survey report on the application of different types of digital system.
2. Prepare a comparison chart on the technical specification and application of different types of memory, PLDs and CPLDS.
3. Conduct a market survey of different digital IC's required for real time applications and present report.

c. Seminar Topics:

1. Embedded systems
2. Microcontrollers
3. Analog to digital converter and vice versa
4. Microprocessor 8085 architecture

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use the appropriate assessment strategy and its weightage in theory, laboratory and Term work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix					
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			
			Assignments	Micro Projects	Other Activities*	
CO-1	15%	15%	15%	20%	20%	**NOT APPLICABLE**
CO-2	25%	25%	25%	20%	20%	
CO-3	25%	25%	25%	20%	20%	
CO-4	20%	20%	20%	20%	20%	
CO-5	15%	15%	15%	20%	20%	
Total Marks	**30**	**70**	**20**	**20**	**10**	
			50			

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant Cos Number(s)	Total Marks	ETA (Marks)		
				Remember I	Understanding (U)	Application & above (A)
Unit-1.0 Basic structure of computers and number system	6	CO-1	10	4	2	4
Unit-2.0 Basic of gates and Boolean Algebra	12	CO-2	18	4	4	10
Unit-3.0 Sequential and combinational Circuits	14	CO-3	18	4	4	10
Unit-4.0 Central Processing Unit and Instruction	8	CO-4	14	4	4	6
Unit-5.0 Memory and I/O Organization	8	CO-5	10	4	2	4
Total	**48**	**-**	**70**	**20**	**16**	**34**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical): (Not Applicable)

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software: (Not Applicable)

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Digital Principles and Applications	Donald P Leach, Albert Paul Malvino, Goutam Saha	McGraw Hill Education; Eighth edition. ISBN-10: 9789339203405 ISBN-13: 978-9339203405
1	Digital Design and Computer Architecture	David Harris, Sarah Harris	Morgan Kaufmann SBN-10: 9789382291527 ISBN-13: 978-0123944245
2	Computer Architecture: A Quantitative Approach, 6th Edition	John L. Hennessy	Morgan Kaufmann
3	Computer System Architecture	M. Morris Mano	Pearson publication ISBN-13:9788131700709
4	Digital Design (4th Edition)	M. Morris Mano; Michael D. Ciletti	Pearson publication, Latest Edition ISBN: 81203-04179

(b) Online Educational Resources:

1. https://dl.acm.org/doi/book
2. https://en.wikipedia.org/wiki/Digital design
3. https://www.javatpoint.com/computer-Architecture-tutorial
4. https://www.elsevier.com/books/harris

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

******

A) Course Code : **2444303(T2444303/P2444303/S2444303)**

B) Course Title : Introduction to Internet of Things

C) Pre- requisite Course(s) : Digital Electronics, Electronics Circuits, Fundaments of Computers, Computer networks

D) Rationale :

The Internet of Things (IoT) has emerged as a field that has the capability to connect almost every devices/appliance used in real life, thus this technology has got its applications in all the domains of engineering and science. This course focuses on the development of IoT concepts with implementation of communication protocols. The course also focuses on real life aspects of IoT and ways to integrate it in real life projects. Overall, after going through this course, students will get exposure to use necessary hardware and software to develop IoT based solutions practically.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Implement elementary IoT set-up

CO-2 Set-up IoT environment based on different communication protocol

CO-3 Use appropriate sensors and software for the specific IoT environment

CO-4 Integrate APIs, client-server connections for developing real life IoT applications.

CO-5 Build and test a complete working IoT system involving prototyping, programming, and data analysis

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)*	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	-	-	-	-	-	-		
CO-2	1	2	2	2	2	-	-		
CO-3	1	3	2	2	2	2	2		
CO-4	1	1	2	3	-	2	2		
CO-5	1	1	3	2	2	3	3		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Teaching & Learning Scheme (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2444303	Introduction to Internet of Things	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2444304	Introduction to Internet of Things	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done internally (40%) as well as **externally (60%).** Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2444303

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the concept of IoT. *TSO 1b.* Explain the functions of each block of the Basic IoT system. *TSO 1c.* Compare features of various IoT platforms *TSO 1d.* List IoT Real time Applications. *TSO 1e.* Describe the functioning of given real-time applications	**Unit-1.0 Introduction to IoT** 1.1 Basics concepts of IoT, its applications in various domains 1.2 Building blocks and architecture of IoT systems 1.3 Overview of various platforms for IoT (e.g. AWS, AZURE, GCP) 1.4 Types of IoT Devices and their basic functions 1.5 Basic IoT system using Arduino and sensors	**CO-1**
TSO 2a. Explain the architecture of given communication protocol. TSO 2b. Explain working and Architecture of blue tooth as IoT communication protocol TSO 2c. Explain working and Architecture of ZigBee as IoT communication protocol TSO 2d. Explain working and Architecture of MQTT as IoT communication protocol TSO 2e. Explain working and Architecture of CoAp as IoT communication protocol TSO 2f. Explain working and Architecture of Wi-fi as IoT communication protocol	**Unit 2.0 IoT Communication Protocols** Working and architecture of communication protocol for IoT Applications 2.1 MQTT 2.2 Bluetooth Low Energy 2.3 ZigBee 2.4 CoAp 2.5 HTTP 2.6 Wi-fi	**CO2**
TSO 3a. Differentiate between sensor and Actuator. TSO 3b. Classify IoT sensors on the basis of their application. TSO 3c. Describe the function of each component of Node MCU. TSO 3d. Explain the procedure to connect sensors with Node MCU.	**Unit-3.0 Sensors and Hardware for IoT** 3.1 Sensors and Actuators, Transducers, Classifications of sensors, IoT Sensors 3.2 Development Boards, classifications, and basics of wireless networks, Wi-Fi libraries 3.3 Introduction to node MCU, block diagram, functions, interfacing with sensors and publishing data on webserver 3.4 Device integration with node MCU Interfacing of sensors with boards	**CO-3**
TSO 4a. Describe different APIs and its uses *TSO 4b.* Explain working and application of REST. *TSO 4c.* Explain working and application of SOAP *TSO 4d.* Explain working and application of JSON in IoT application development.	**Unit.4.0 IoT APIs and its Integration** 4.1 Explain APIs and its use 4.2 Explanation of given IoT APIs along with its applications 4.3 MQTT, Broker, subscriber, publisher 4.4 REST 4.5 SOAP 4.6 JSON 4.7 Programming API using Python	**CO-4**
TSO 5a. Compare features of various IoT platforms, such as AWS IoT, Azure IoT, and Google Cloud IoT *TSO 5b.* Differentiate between industrial IoT and IoT. *TSO 5c.* Describe the uses of IoT for consumer electronics products. *TSO 5d.* Describe the applications of IoT in different domains in real life.	**Unit. 5.0 IoT Applications**: - 5.1 Popular IoT platforms and their features, such as AWS IoT, Azure IoT, and Google Cloud IoT. 5.2 Industrial IoT and Internet of everything 5.3 IoT for consumer electronics products 5.4 IoT for Medical applications 5.5 IoT for Agriculture 5.6 IoT for security and Law enforcement	**CO-5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2444303

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Establish connectivity between various components of IoT system. *LSO 1.2.* Develop C programs to control IoT system. *LSO 1.3.* Develop geometrical model of given IoT System	1.	a) Establish connectivity between various components of IoT, such as between LED and on/off Switches b) Write small C program in Arduino UNO to check the input/output functions of various sensors. c) Design small IOT Device using tinkercad and implement it using UNO board and sensors.	CO-1
LSO 2.1. Establish IOT device connection using Wi-Fi *LSO 2.2.* Establish connection between Arduino and Bluetooth module. *LSO 2.3.* Configure MQTT-based communication between IoT devices and a cloud platform. *LSO 2.4.* Implement CoAP-based smart home system with interoperability between devices	2.	a) Connect IOT device using Wi-Fi b) Connect Arduino and Bluetooth module. c) MQTT-based communication between IoT devices and a cloud platform. d) CoAP-based smart home system implementation	CO-2
LSO 3.1 Publish data generated through given IoT system. LSO 3.2 Implement IOT based temperature data-monitoring system. LSO 3.3 Implement IOT based humidity data-monitoring system. LSO 3.4 Implement IOT based pressure data-monitoring system.	3.	a) Create a sample IoT environment, collect and publish data on the Server. b) Measure the temperature of a remotely located temperature sensor Using IOT based temperature data-monitoring system. c) Measure the humidity of a remotely located humidity sensor Using IOT based humidity data-monitoring system. d) Measure the pressure of a remotely located pressure sensor Using IOT based pressure data-monitoring system.	CO-3
LSO 4.1. Use software testing tools used for API testing *LSO 4.2.* Implement given type of APIs using POSTMAN Application.	4	a) Download and Configure POSTMAN Application b) Demonstrate the use of REST APIs through POSTMAN. c) Demonstrate the use of JSON APIs through POSTMAN. d) Demonstrate the use of SOAP APIs through POSTMAN.	CO-4
LSO 5.1. Configure and manage the communication and data flow between the IoT devices and the cloud platform *LSO 5.2.* Deploy IoT devices on a cloud-based IoT platform, such as AWS IoT Core or Azure IoT Hub. *LSO 5.3.* Identify components required for a given IoT application	5.	a) Develop a prototype IoT Application using a selected platform b) Deploy and manage IoT devices on a cloud-based IoT platform c) Identify components for given project	CO-5

L) Suggested Term Work and Self Learning: S2444303 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Prepare a report on IoT Systems using Internet data.
2. Carry-pout market survey and submit report to identify various types of IoT sensors, their applications and pricing.
3. Interface IR sensor with Arduino and send the data to Arduino cloud.
4. Prepare a complete IoT system for given application using sensors, Arduino, necessary communication technology
5. Make a complete report on cost estimation of IoT based project. It includes components identification, cost of software, hardware, technological requirement, design, set-up and deployment cost.

c. Other Activities:

1. Seminar Topics: -

   - Various technologies for IoT
   - Future of IoT
   - Smart City and IoT
   - IoT based waste management system
   - Smart vehicle parking system
   - Air pollution monitoring system

2. Visit nearby industry to observe Industrial applications of IoT. Prepare and submit report of visit with emphasis on types of sensor, hardware, software, communication protocol and platform used.

d. Self-Learning Topics:

1. IoT hardware and their use for various applications
2. IoT sensors technical specifications
3. IoT enabled services

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	20%	20%	10%	10%
CO-2	25%	25%	25%	20%	20%	20%	20%
CO-3	15%	15%	15%	20%	20%	25%	25%
CO-4	25%	25%	25%	20%	20%	25%	25%
CO-5	20%	20%	20%	20%	20%	20%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to IoT	8	CO-1	10	4	4	2
Unit-2.0 IoT Communication Protocols	12	CO-2	17	6	4	7
Unit-3.0 Sensors and Hardware for IoT	8	CO-3	10	2	4	4
Unit-4.0 IoT APIs and its Integration	12	CO-4	18	4	6	8
Unit-5.0 IoT Applications	8	CO-5	15	4	4	7
Total Marks	**48**	**-**	**70**	**20**	**22**	**28**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1	a) Establish connectivity between various components of IoT, such as between LED and on/off Switches	CO-1	40	50	10
	b) Write small C program in Arduino UNO to check the input/output functions of various sensors.	CO-1	30	60	10
	c) Design small IOT Device using tinkercad and implement it using UNO board and sensors.	CO-1	40	50	10
2	a) Connect IOT device using Wi-Fi	CO-2	40	50	10
	b) Connect Arduino and Bluetooth module.	CO-2	40	50	10
	c) MQTT-based communication between IoT devices and a cloud platform.	CO-2	40	50	10
	d) CoAP-based smart home system implementation	CO-2	40	50	10
3.	a) Create a sample IoT environment, collect and publish data on the Server.	CO-3	40	50	10
	b) Measure the temperature of a remotely located temperature sensor Using IOT based temperature data-monitoring system.	CO-3	40	50	10
	c) Measure the humidity of a remotely located humidity sensor Using IOT based humidity data-monitoring system.	CO-3	40	50	10
	d) Measure the pressure of a remotely located pressure sensor Using IOT based pressure data-monitoring system	CO-3	40	50	10
4.	a) Download and Configure POSTMAN Application	CO-4	30	60	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
	b) Demonstrate the use of REST APIs through POSTMAN.	CO-4	30	60	10
	c) Demonstrate the use of JSON APIs through POSTMAN.	CO-4	30	60	10
	d) Demonstrate the use of SOAP APIs through POSTMAN.	CO-4	30	60	10
5.	a) Develop a prototype IoT Application using a selected platform	CO-5	30	60	10
	b) Deploy and manage IoT devices on a cloud-based IoT platform	CO-5	30	60	10
	c) Identify components for given project	CO-5	30	60	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
	Bluetooth Modem-BlueSMiRF Silver	Sparkfun Bluetooth modem,	1-5
	LED	Different color LEDs	1-5
	Arduino UNO board	14 digital input/output, 6 analog inputs, 16 MHz ceramic resonator, USB connection, power jack, ICSP header and a reset button	1-5
	Postman Software	Open-source downloadable	4
	Node MCU board	Generic ESP8266 Nodemcu Esp8266 Lua Amica Wifi Internet of Things Development Board Cp2102 Io	1-5
	IoT free cloud	Arduino cloud/ThingSpeak/Blynk	2,3,4,5
	Sensors	temperature, humidity, pressure, object and more as required	3, 4, 5
	ATAL tinkering Lab Package-1 Package-2 Package-4	As per the list available on below given link- ATAL Equipment list https://aim.gov.in/pdf/ATL-Equipment-Batch-of-60.pdf	1-5

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Internet of Things Architecture and Design Principles	Raj Kamal	Mc Graw Hills, New Delhi ISBN 13: 978-93-90722-38-4
2	Internet of things (IoT) : technologies, applications, challenges and solutions	BK Tripathy, J Anuradha	CRC Press , ISBN 9780367572921, June 30, 2020
3	Internet-of-Things (IoT) Systems: Architectures, Algorithms, Methodologies	Dimitrios Serpanos &Marilyn Wolf	Springer; 1st ed. 2018 edition (17 January 2018)
4	Custom Raspberry Pi Interfaces: Design and build hardware interfaces for the Raspberry	Pi by Warren Gay	Apress; 1st ed. edition (23 February 2017), ISBN-10 : 9781484224052, ISBN-13 : 978-1484224052
5	'Learning Internet of Things',	Peter Waher	Packt Publishing, 2015, ISBN 9781783553532, https://lib.hpu.edu.vn/handle/123456789/31693
6	Sensors, Actuators and Their Interfaces,	N. Ida	Scitech Publishers, 2014.

(b) Online Educational Resources:

1. https://nptel.ac.in/courses/106105166
2. https://oercommons.org/authoring/57202-introduction-to-internet-of-things/2/view
3. https://www.javatpoint.com/IoT-internet-of-things
4. https://www.tutorialspoint.com/internet of things /index.htm

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students

(c) Others:

1. Manufacturers' Manual
2. Lab Manuals

****

A) Course Code : 2444304(T2444304/P2444304/S2444304)

B) Course Title : Database Management System (CSE, AIML)

C) Pre- requisite Course(s) : ICT Tools

D) Rationale :

Database Management System (DBMS) is a vital components of information systems for development of any software application. Any software application deals with large data set which has to be properly organized to provide necessary input to the application. The DBMS focuses on structures and principles necessary to design and implement a database management system.

In this course Students will learn the approach and process of good database designs. Student will also learn to use Structured Query Language to create and manipulate database appropriately to serve the requirement of given software application.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Illustrate the fundamental concepts of Database, Database System and Database Management System.

CO-2 Use the concepts of E-R Modeling, Keys and constraints to design a database

CO-3 Normalize/De-normalize the database to optimize its performance

CO-4 Use Structured Query Language (SQL) for database manipulation

CO-5 Create and use schema objects such as View, Index, Synonyms and Sequence to optimize database performance.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	1	-	-		-	-	1		
CO-2	-	1	-	1	-	-	-		
CO-3	-	2	2	1	1	-	1		
CO-4	2	1	2	1	1	-	-		
CO-5	1	1	2	1	1	-	-		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2444304	Database Management System	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment(TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2444304	Database Management System	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done internally (40%) as well as externally (60%). Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2444304

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Illustrate concept of Database Management System. *TSO 1b.* State the importance of DBMS over file processing. *TSO 1c.* Describe the overall structure of the given DBMS *TSO 1d.* Explain the characteristics of Relational database model *TSO 1e.* Explain characteristics of given Database systems.	**Unit-1.0 Overview of the Database Management System** 1.1 Database- Concept of database, Need of Database, Advantage of database, Application of Database, Traditional Database 1.2 Database Management System, File Processing System, Advantages of DBMS over file processing system, Characteristic of Database 1.3 Relational Data Model- Domain, Attributes, Tuples and Relations 1.4 Types of Database System-Centralized Database System, Parallel Database System, Client / Server Database System, Distributed Database System	**CO-1**
TSO 2a. Describe the given term related to RDBMS *TSO 2b.* Describe the given components of E-R diagram. *TSO 2c.* Explain the purpose of given type of Key in DBMS *TSO 2d.* Apply given Integrity Constraint on database. *TSO 2e.* Convert given E-R diagram into Table	**Unit-2.0 Relational Database Management System (RDBMS):** 2.1 Introduction to RDBMS, RDBMS terminology. Relational Model (Instances, Schema). 2.2 E-R model concept- Notation for E-R diagram, Component of E-R diagram, Strong Entity set, Weak Entity set, Types of Attributes, E-R design Issues 2.3 Keys in DBMS- Primary key, Candidate key, Foreign key, Super Keys, Alternate Keys 2.4 Integrity Constraints- Domain Constraint, Entity Integrity Constraint, Referential Integrity Constraint, Key Constraint 2.5 Conversion of E-R diagram into Table	**CO-2**
TSO 3a. Find Functional Dependencies in a relation for good database design. *TSO 3b.* Describe closure properties in database. *TSO 3c.* Normalization the given database from one normal form to other normal form. *TSO 3d.* De-normalize database for optimizing its performance.	**Unit 3.0 Relational Database Design:** 3.1 Functional Dependency, Closures of a Set of Functional Dependencies. 3.2 Normalization & Normal forms- 1NF, 2NF, 3NF, BCNF 3.3 Denormalization: Process, benefits and draw back.	**CO-3**
Major Theory Session Outcomes (TSOs)	**Units**	**Relevant COs Number(s)**
TSO 4a. Describe the use of given relational algebra operator with example. *TSO 4b.* Explain the given join operation on tables with example. *TSO 4c.* Write SQL queries for adding, deleting and updating table data. *TSO 4d.* Write queries by implementing given aggregate functions on data. *TSO 4e.* Write SQL queries to display the data in sorted order. *TSO 4f.* Combine the data as per given criteria *TSO 4g.* Write SQL Statement to join two relations	**Unit 4.0 Relational Algebra & SQL:** 4.1 Concept of relational algebra 4.2 Types of relational operations- Select operation, Project operations, Union operations, Set Intersection operations, Set Difference operations, Cartesian operations, Rename operations 4.3 Join operations- Natural Join, Outer Join, Equi Join 4.4 Overview of SQL- SQL Commands - Data Definition language(DDL), Data Manipulation Language(DML), Data Control Language(DCL) - Select, Insert, Update, Delete SQL Statements	**CO-4**

TSO 4h. Write Correlated and Nested Query *TSO 4i.* Write SQL to control the database transaction	4.5 SQL Clauses- Group by, Having, Order by clause 4.6 Aggregate functions- Max, Min, Sum, Count, Avg 4.7 SQL Join Operations, Inner join, Left join, Right join, Full join 4.8 SQL Queries - Correlated and Nested Query 4.9 TCL: Commit, save point, rollback, set transaction	
TSO 5a. Write SQL statement to create and manipulate view *TSO 5b.* Write SQL statement to create and manipulate sequence. *TSO 5c.* Write SQL to create and drop Index in table. *TSO 5d.* Write SQL to create and drop synonyms in database	**Unit 5.0 Other Schema Objects** 5.1 Views: Concept of View, The Create and update Views, Views and Joins, Views and Sub queries, Dropping Views. 5.2 Sequences: Concept and need of Sequence Creating Sequences, Altering Sequences, Dropping Sequences. 5.3 Indexes: need of index, index Types, creating of an Index: Simple Unique, and Composite Index, Dropping Indexes 5.4 Synonyms: Creating Synonyms, Dropping Synonyms.	**CO-5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2444304

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Install and configure Database product.	1.	Database installation (such as MySQL, MariaDB)	CO-4
LSO 2.1. Write and execute DDL command to create a database for the identified problem	2.	Design table structure	CO-4
LSO 3.1. Apply given integrity constraint on table	3.	Apply integrity constraints	CO-4, CO-2
LSO 4.1. Write and execute DML commands to insert, delete and update data	4.	Use DML commands.	CO-4
LSO 5.1. Write and execute queries using relational algebraic operations.	5.	Apply relational algebraic operations	CO-4
LSO 6.1. Use given aggregate function in SQL Query	6.	Write statements to demonstrate the use of aggregate functions	CO-4
LSO 7.1. Implement different join operations using queries	7.	Perform join operations	CO-4
LSO 8.1. Write and execute Correlated and Nested Query for given problem	8.	Write Correlated and Nested Query	CO-4
LSO 9.1. Perform Transaction control operations on a database	9.	Write TCL Queries	CO-4
LSO 10.1. implement concept of view to optimize database handling	10.	Implement Views to perform following operations: a. Create views. b. Insert, modify and delete records through views. c. Delete the views.	CO-5
LSO 11.1. implement Synonyms for Database usage simplification and flexibility *LSO 11.2.* Create and use index for efficient access of ordered records. *LSO 11.3.* Create and use sequences to avoid possible concurrency	11.	Create Indexes, Sequences, and Synonyms in SQL.	CO-5

L) Suggested Term Work and Self Learning: S2444304 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

- Teachers are suggested to identify various systems for computerization and students can be assigned to make E-R diagram (which can later be converted in to tables) to design suitable database.
- Normalize the given table to successive Normal form

b. Micro Projects:

1. Identify various Entity and attributes and relation between them for Library Management System.
2. Draw ER Diagram for Hospital Management System Database.
3. Identify a system, create database and Normalize the database consecutively up to 3NF
4. Prepare a presentation on by taking an example

c. Other Activities:

1. Seminar Topics: -

- Importance of Database Management System.
- various vulnerabilities in database management systems
- Database recovery techniques
- Concurrency control in database

2. Self-Learning Topics:

- Hierarchical and network Database System
- Transaction management: ACID properties

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use the appropriate assessment strategy and its weightage in theory, laboratory and Term work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	10%	-	-	-	-
CO-2	25%	25%	30%	25%	-	-	-
CO-3	15%	15%	30%	25%	33%	-	-
CO-4	25%	25%	15%	25%	33%	60%	60%
CO-5	20%	20%	15%	25%	34%	40%	40%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 An Overview of the Database Management System	9	CO-1	11	5	6	0
Unit 2.0 Relational Database Management System (RDBMS)	10	CO-2	17	3	6	8
Unit 3.0 Relational Database Design	9	CO-3	10	4	2	4
Unit 4.0 Relational Algebra & SQL	12	CO-4	18	4	6	8
Unit 5.0 Other Schema Objects	8	CO-5	14	4	4	6
Total	**48**	**-**	**70**	**20**	**24**	**26**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Database installation (such as MySQL, MariaDB)	CO-4	80	20	-
2.	Design table structure	CO-4	40	60	10
3.	Apply integrity constraints	CO-4, CO-2	40	60	10
4.	Use DML commands.	CO-4	40	60	10
5.	Apply relational algebraic operations	CO-4	40	60	10
6.	Write statements to demonstrate the use of aggregate functions	CO-4	40	50	10
7.	Perform join operations	CO-4	40	50	10
8.	Write Correlated and Nested Query	CO-4	40	50	10
9.	Write TCL Queries	CO-4	80	10	10
10.	Implement Views to perform following operations: a. Create views. b. Insert, modify and delete records through views. c. Delete the views.	CO-5	40	50	10
11.	Create Indexes, Sequences, and Synonyms in SQL.	CO-5	30	60	10

Legend:

PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	**Broad Specifications** (No Generic) Give basic configuration or Latest	Relevant Experiment/Practical Number
1.	Computer System	Any General-purpose Computer with 8GB RAM/500GB HDD	1-11
2.	Any DBMS Product	preferably open source based, such as MySQL/ MariaDB or Any other	1-11

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Database Management Systems (Dbms)	Dr. Rajiv Chopra	S Chand Publishing; Fifth edition, ISBN-10: 9385676342 ISBN-13: 978-9385676345
2	Fundamentals of Database Systems,	R. Elmasri, S. Navathe	Seventh Edition, Addison Wesley, ISBN-13: 978-9332582705
3	Database System Concepts	Abraham Silberschatz, Henry F. Korth, S. Sudarshan	7th Edition, McGraw Hill ISBN-10 : 9390727502 ISBN-13 : 978-9390727506
4	Introduction to database system (8th Edition)	C. J. Date	Pearson, ISBN- 0-321-18956-6, ISBN-13: 978-0074622391
5	An Introduction to Database Systems,	B. Desai	Galgotia Publication (Revised Edition) ISBN · 9788175156173

(b) Online Educational Resources:

1. https://nptel.ac.in/courses/106104128
2. https://www.tutorialspoint.com/dbms/index.htm
3. https://www.w3schools.com/c/
4. https://www.javatpoint.com/dbms-tutorial

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Lab Manuals

*****

A) Course Code : 2400305(T2400305/S2400305)

B) Course Title : Mathematics (Probability and Statistics)

C) Pre- requisite Course(s) : Basic Engineering Mathematics, Applied Mathematics

D) Rationale :

This course on probability and statistics provides essential knowledge and skills for artificial intelligence (AI) and machine learning (ML) due to providing a strong foundation for understanding and applying various concepts and techniques. It enables students to analyze and interpret data, design effective algorithms, evaluate model performance and make informed decisions. Probability theory is a fundamental concept in machine learning as it is used to model uncertainty and make probabilistic predictions. Random variables and probability distributions are used to represent the uncertainty in the data and the predictions made by the model. Correlation measures the strength and direction of the relationship between two variables while regression allows us to predict the value of one variable based on the value of another. Moreover, analyzing data using statistical tools and techniques is essential for validating data, making evidence-based decisions and advancing knowledge in diverse fields. The course will also integrate to ensure that students have a strong quantitative foundation to excel in the field of AI & ML real-world problems.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

- **CO-1** Apply the concepts of probability to solve AI & ML engineering related problems.
- **CO-2** Use the concepts of random variables to model probability distribution of data used in AI & ML.
- **CO-3** Use probability distribution as a tool to solve branch specific problems.
- **CO-4** Compare data using correlation and regression techniques for given applications.
- **CO-5** Analyse data using statistical tool and techniques.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	-	2	-	-	-	1		
CO-2	3	2	-	-	-	-	-		
CO-3	3	2	-	-	-	-	-		
CO-4	3	2	-	-	-	-	-		
CO-5	3	-	2	1	-	1	1		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400305	Probability and Statistics	02	01	-	02	05	04

Legend:

CI: Classroom Instruction (Includes different instructional/ implement at ion strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/ practical performances / problem-based experiences in laboratory, workshop, field or other locations using different instructional/ Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, Spoken Tutorials, online educational resources etc.

C: Credits= (1xCIhours) + (0.5xLIhours) + (0.5xNotionalhours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400305	Probability and Statistics	30	70	20	30	-	-	150

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA Term work & self-learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, and seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing:

Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400305

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Use the concept of conditional probability to solve given problems. *TSO 1b.* Apply the law of Bayes' theorem to calculate conditional probabilities. *TSO 1c.* Solve the given problems based on Bayes' theorem. *TSO 1d.* Use Venn diagrams to represent conditional probability.	**Unit-1.0 Theory of Probability** 1.1 Concepts of Probability 1.2 Conditional Probability 1.3 Bayes' theorem 1.4 Application of Bayes' Theorem	**CO1**
TSO 2a. Distinguish between discrete and continuous random variables. *TSO 2b.* Calculate Mathematical Expectation of a random variable for linear function. *TSO 2c.* Find Mean and Variance of given random variable. *TSO 2d.* Evaluate the moment generating function of given random variables for engineering applications.	**Unit-2.0 Random Variables** 2.1 Concept of Random variable 2.2 Discrete and Continuous Distribution Function. 2.3 Mathematical Expectation, Mean, Variance 2.4 Moment Generating Function	**CO2**
TSO 3a. Differentiate Discrete and Continuous probability distributions. *TSO 3b.* Identify the relationships between different probability distributions. *TSO 3c.* Solve the given problems based on repeated trials using binomial distribution. *TSO 3d.* Use suitable distribution to solve the given problems when numbers of trials are large and probability is very small. *TSO 3e.* Utilize the concept of normal distribution to solve engineering related problems. *TSO 3f.* Apply probability distributions concepts to solve branch specific problems.	**Unit-3.0 Probability Distributions** 3.1 Discrete Probability Distribution: Binomial & Poisson. 3.2 Continuous Probability Distribution: Normal Distribution. 3.3 Area under the Normal curve. 3.4 Applications of the Normal Distribution	**CO3**
TSO 4a. Differentiate correlation and Regression. *TSO 4b.* Identify positive and negative correlations for a given data set. *TSO 4c.* Calculate co-efficient of correlation for a given data set of engineering applications. *TSO 4d.* Compute the degree of similarity using rank correlation coefficient. *TSO 4e.* Use linear regression to find the relationship between variables.	**Unit-4.0 Correlation and Regression** 4.1 Definition of correlation and its significance. 4.2 Coefficient of Correlation. 4.3 Rank of Correlation. 4.4 Linear Regression	**CO4**
TSO 5a. Explain Descriptive Statistics with examples. *TSO 5b.* Plot the given data set using appropriate visualization technique based on engineering problems. *TSO 5c.* Identify different types of plots and charts *TSO 5d.* Differentiate different types of date visualization techniques. *TSO 5e.* Use appropriate data visualization tool for data analysis.	**Unit-5.0 Data Visualization: Tools & Techniques** 5.1 Descriptive Statistics: Elements, Variables (Quantitative and Qualitative) 5.2 Data visualization techniques: bar charts, line plots, scatter plots, histograms 5.3 Data visualization tools: Sage math, Regress+, GeoGebra, Maths3D, SSP, R, Scilab, Excel, Orange, Matplotlib, Seaborn, Plotly, ggplot2, and Tableau.	**CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Tutorials and Outcomes:

Outcomes	S. No.	Tutorials Titles	Relevant COs Number(s)
1.1 Compute probability with the help of any open-source software. 1.2 Use the concept of conditional probability to forecast weather conditions. 1.3 Apply Bay's theorems to find the probability for the problems based on sales and traffic.	1.	• Computation of probability. • Application of conditional probabilities. • Application of Bay's theorem.	CO1
1.1 Use random variables to analyze player performance, team strategies and game outcomes in any sport(s). 1.2 Analyze the call arrivals and service times in call center using the concept of discrete random variables. 1.3 Use continuous random variables to find the weight of a group of students in a class. 1.4 Calculate mathematical expectation, mean and variance of a discrete random variable of the given data. 1.5 Use Moment generating function of a specific distribution to analyze risk in insurance policies.	2.	• Application of random variables. • Application of discrete random variables. • Application of discrete and Continuous random variables. • Application of mathematical expectation. • Application of Mean & variance. • Application of Moment generating function in insurance.	CO2
1.1 Calculate the probability of selling a certain number of books in a fixed duration of time using Poisson distribution. 1.2 Use the binomial distribution to calculate the probability that a certain number of spam emails land in an inbox per day. 1.3 Analyze educational attainment under certain condition in particular village using normal distribution.	3.	• Application of Poisson distribution. • Application of Binomial distribution. • Application of Normal Distribution.	CO3
1.1 Use the concept of correlation predicts traffic flow in a given region. 1.2 Identify the correlation between different economic indicators and stock prices in financial forecasting. 1.3 Calculate the correlation coefficient between the two variables to determine strong linear relationship. 1.4 Prepare a linear regression model for the given data to find the line of regression.	4.	• Correlation and its application in traffic flow. • Correlation in financial forecasting. • Correlation coefficient to determine relationship between two variables. • Model to find the line of regression.	CO4
1.1 Apply the concept of Quantitative variables to study human behavior and social phenomena. 1.2 Apply the concept of Qualitative variables to find the course related Feedback and Surveys. 1.3 Use bar graph to compute the average rainfall for a region over a period of time. 1.4 Apply the Scatter plot to examine relationships between risk factors and health outcomes. 1.5 Use Histogram to visualize the distribution of student marks on standardized tests. 1.6 Visualize given data using suitable tools.	5.	• Application of Quantitative and Qualitative variables. • Data visualization techniques. • Data visualization tools.	CO5

L) Suggested Term Work and Self Learning: S2400305 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

1. Consider a medical scenario with two possible diseases and three symptoms. Calculate the posterior probabilities of each disease given the observed symptoms using Baye's theorem.
2. Describe how conditional probability is used in classification algorithms such as logistic regressions.
3. Define the expectation and variance of a random variable and their significance in AI & ML.
4. Compare and Contrast discrete and continuous random variables in the context of AI & ML.
5. Design a fraud detection model that utilizes the binomial distribution to estimate the likelihood of fraudulent activities using open-source software.
6. Explain the role of the normal distribution in Statistical hypothesis testing in AI & ML.
7. Design a simple recommender system that utilizes user-item correlation to make personalized recommendations using open-source software.
8. Design a linear regression model to predict a continuous target variable based on set of input features using open-source software.
9. Explain the importance of data visualization in exploratory data analysis.
10. Choose a dataset with two continuous variables and create a scatter plot to display the relationship between the variables.

b. Micro Projects:

1. Develop a spam email classifier using machine learning algorithms.
2. Prepare fraud detection Algorithms by using the concept of AI & Machine Learning.
3. Prepare user engagement model using the concept of random variables.
4. Develop a model for predicting equipment failures or maintenance needs using random variables.
5. Prepare chart for checking performance of computer system using suitable algorithm.
6. Build regression models to predict the computer prices based on the selected features.
7. Prepare chart for advantages and limitations of continuous and discrete probability distributions for modeling AI & ML datasets.
8. Prepare chart for different computer components using concept of correlation and regression.
9. Prepare chart on Data visualization tools and techniques for AI & ML.

c. Other Activities:

1. Seminar Topics:
    - Blog on the importance of probability and Statistics in AI & ML.
    - Application of probability and Statistics in AI & ML.
    - Application of Bayes' theorem in machine learning algorithms.
    - Real-world applications of random variables.
    - Mathematical expectation and its significance in probability theory.
    - Binomial Distribution: Properties and Applications.
    - Comparison of Binomial and Poisson Distributions.
    - Real life Applications of the Normal Distribution.
    - Applications of Linear Regression in AI & ML.
    - Applications of correlation in daily life.
    - Use of correlation in predicting traffic patterns in transportation systems.
    - Data visualization tools & techniques.
    - Need of Open-source software for Probability & Statistics in AI & ML.

2. Visits: Visiting following places would provide students an opportunity to see the application of various branches of mathematics in different fields. This will also help students to comprehend the career opportunities available in the field of mathematics.
    - Visit to a Science Museum.
    - Visit to a mathematics research institute.
    - Visit to a Data Science Center.
    - Visit to a mathematics department of a college or university.
    - Visit to a software company.
    - Visit to a Space Agency.
    - Visit to a Game Studio.

3. Self-Learning Topics:
    - Participate in MOOCs based Course on Data Visualization: Tools & Techniques offered from Foreign University
    - Participate in MOOCs based Course on Probability: Methods and Applications.
    - Participate in MOOCs based Course on Statistics and its Engineering applications.
    - Participate in MOOCs based Course on Open source software used for AI & ML.

M) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		**Term Work Assessment (TWA)**			**Lab Assessment (LA)#**	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	**End Theory Assessment (ETA)**	**Term Work& Self Learning Assessment**			**Progressive Lab Assessment (PLA)**	**End Laboratory Assessment (ELA)**
			Assignments	**Micro Projects**	**Other Activities***		
CO-1	10%	10%	10%	20%	5%	20%	20%
CO-2	15%	15%	15%	20%	10%	10%	20%
CO-3	20%	20%	20%	20%	25%	15%	20%
CO-4	25%	30%	25%	20%	30%	15%	20%
CO-5	30%	25%	30%	20%	30%	40%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each Cos.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Theory of Probability	8	CO1	7	3	2	2
Unit-2.0 Random Variables	8	CO2	11	3	4	4
Unit-3.0 Probability Distributions	8	CO3	15	5	6	4
Unit-4.0 Correlation and Regression	12	CO4	19	5	8	6
Unit-5.0 Data Visualization: Tools & Techniques	12	CO5	18	4	8	6
Total	**48**	**-**	**70**	**20**	**28**	**22**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested AssessmentTable for Laboratory (Practical): (Not Applicable)

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	High end computers	Processor Intel Core i7 with Compilers and Programming Languages, RAM 32 GB, DDR3/DDR4, HDD 500 GB, OS Windows 10	All
2.	Software	Scientific Calculators, Graphing Calculator, SCILAB, GraphEq^2.13, Micro soft Mathematics, GeoGebra, Math3D	1,2,3,4,5
3.	Printer	High Speed Duplex Printer	
4.	Scanner	Handheld 3D scanner, Accuracy up to 0.1 mm, Resolution upto 0.2 mm, Wireless technology with an inbuilt touch screen and battery, Extended field of view for capturing both large and small objects	

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Probability for Statistics and Machine Learning	Anirban Das Gupta	Springer New York Dordrecht Heidelberg London ISBN: ISBN 978-1-4419-9633-6 e-ISBN 978-1-4419-9634-3
2.	Probability and Computing Randomized Algorithms and Probabilistic Analysis	Michael,Mitzenmacher and Eli Upfal	CAMBRIDGE UNIVERSITY PRESS ISBN: 0521 835402
3.	An Introduction to Statistical Learning with Applications in R	Gareth James, Daniela Witten, Trevor Hastie Robert and Tibshirani	Springer New York Heidelberg Dordrecht London, ISBN 978-1-4614-7137-0 ISBN 978-1-4614-7138-7 (eBook)
4.	Python for Probability, Statistics, and Machine Learning	José Unpingco	Springer International Publishing Switzerland

			ISBN 978-3-030-18544-2 ISBN 978-3-030-18545-9 (eBook)
5.	Advanced Engineering Mathematics	Ervin Krezig	Wiley Publ., New Delhi,2014, ISBN: 978-0-470-45836-5
6.	Elementary Engineering Mathematics	B. S. Grewal	Khanna Publishers,15th Edition. ISBN: 978-81-7409-257-1

(b) Online Educational Resources:

1. https://ocw.mit.edu/
2. https://tutorial.math.lamar.edu/
3. https://www.khanacademy.org/
4. https://www.feynmanlectures.caltech.edu/
5. https://www.wolframalpha.com/
6. https://www.dplot.com/
7. https://www.geogebra.org/
8. https://www.easycalculation.com/
9. https://www.scilab.org/
10. https://www.desmos.com/
11. https://nptel.ac.in/
12. https://swayam.gov.in/
13. https://ndl.iitkgp.ac.in/
14. https://parakh.aicte-india.org/
15. https://ekumbh.aicte-india.org/
16. https://learnengg.com/LE/Index

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Online Mathematics Courses.
2. Mathematics Communities and Forums.
3. Mathematics Journals.
4. Mathematics Podcast.
5. Mathematics Tutorials.
6. Mathematics Quizzes.
7. Mathematics Animation.
8. Mathematics Simulations.
9. Mathematics Games.
10. Mathematics Puzzles.
11. Mathematics Brain Teasers.
12. Mathematics Apps.
13. Mathematics Blog.
14. Mathematics Challenges.

******

A) Course Code : 2444306(P2444306/S2444306)

B) Course Title : Summer Internship -I (Common For all Programmes)

C) Pre- requisite Course(s) :

D) Rationale :

Diploma students are required to give exposure of their own diploma programme related industrial hardware, software and practices, just after completing one semester, so that they can correlate this industrial exposure with the concept being taught in the branch specific specialized engineering courses in forthcoming semesters. Mentors/Coordinators/ Teachers need to map the academic contents of the programme of study with the activities of this industrial exposure and are advised to follow the 'Whole to Part' approach to make the students aware about the potential industry's expected outcomes & setup ('Whole') from the diploma programme – and then teaching the related concepts ('Part') of the same in subsequent semesters. In this way before actually being exposed to academic input specific to diploma programmes, the students need to be sent to the nearby/local industries and also may be advised to explore information related to their programme of study using different sources related to potential employment opportunities of both wage and self-employment, job function, job position, nearby relevant industries and so on.

The summer internship will provide the direction to the students and also help in mind mapping to plan their futuristic course of action, after passing the diploma. This would also bridge the gap between their virtual imagination about the outcome of the programme and real happenings related to the diploma programme.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

- **CO-1** Comprehend the practices of identified industry or world of work related to diploma engineering programme of study.
- **CO-2** Map real equipment, processes, product, management, operations etc. to the course of study through various glimpses of input, process and output in different type of industries.
- **CO-3** Identify the probable enterprises /startups for futuristic planning and self-growth.
- **CO-4** Identify the probable job function and job position in their relevant programme of study.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	-	-	1	-	-	1		
CO-2	3	-	-	1	-	-	1		
CO-3	3	-	-	-	1	-	2		
CO-4	3	-	-	-	1	-	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2444306	Summer Internship -I	-	-	02	02	04	02

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2444306	Summer Internship -I	-	-	10	15	10	15	50

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Suggested Instructional/Implementation Strategies: Mentors/ Coordinators/ Teachers need to plan and implement the summer internship in their respective programme as per the outcome expected from the programme. However in general, summer internship would help in exploring and exposing the student to the below mentioned dimensions of the world of work. These dimensions can further be explored in depth as per the need and advancement in respective programmes in later stages. Mentors/Coordinators/ Teachers need to map the academic contents of the programme of study with the activities of this industrial exposure and are advised to follow the whole to part approach to make the students aware about the potential industry's expected outcomes & setup ('Whole') from the specific diploma programme and then teaching the related concepts ('Part') of the same in subsequent semesters.

- Industrial Layout
- Organizational Structure
- Corporate Communications
- Strategic, Rolling and Developmental plans
- Maintenance Procedures
- Inventory Control and Management System
- Purchase and Store Procedures
- Major Machinery, Tools, Equipment, Devices, Software, Control System etc.
- Product Development, Manufacturing, Packaging and Delivery
- Project Management
- Operation and Maintenance
- Warehouse Management
- Assembly Line
- Quality Assurance and Testing Cell
- Process/ Software Development/ Fabrication/ Construction Work Management
- Testing and Quality Assurance Practices
- Total quality management
- Calliberation and Certification practices
- Safety Practices
- Industrial Acts
- Industrial Grievances
- Behavioural Aspects
- Conduction of Meetings and Discussions
- Sales and Marketing Strategies
- Forecasting and Target Setting
- Production Planning and Control
- Storage Retrieved and Material handling Practices
- Automation and Control Facilities
- Enterprise Resource Planning (ERP)
- Supply Chain
- Customer Satisfaction Strategies
- Finance and Accounts
- Research and Development
- Promotion and Capacity Building Schemes
- Reduce, Reuse and Recycling Efforts and Policies
- Recognitions and Rewards
- After Sale Services
- Promotional Avenues
- Social Corporate responsibilities

J) Assessment of Summer Internship -I

S. No.	Criteria of Assessment	% of Weightage
1.	Maintaining the log book after having exposure to different types of industry/ world of work	15
2.	Preparing the list of job functions and job positions of relevant programme	20
3.	Identify the probable enterprise/ startup for futuristic planning	15
4.	Report writing of summer internship as per the prescribed format	30
5.	Presentation of Report	20
Total		**100**

Note: S. no. 1 to 3 shall be considered for progressive assessment. While S. No. 4 & 5 shall be considered for end term assessment

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A) Course Code : **2400107(T2400107)**

B) Course Title : Professional Ethics

(CE, CSE, ELX, ELX (R), FTS, ME, AIML, MIE, CHE, CRE, FPP, GT, EE, AE, CACDDM)

C) Pre- requisite Course(s) : General awareness about moral values and different workplaces

D) Rationale :

One of the programme outcomes of the diploma course incorporates ethical practices in application of appropriate technology in context of society, sustainability, environment. It is of great importance to distinguish between the terms values and ethics. Ethics are norms of behaviour that are set by authorities at workplace. The persons belonging to that workplace are expected to follow the norms. Ethical behaviour at workplace affects the person's relation to people, creates a positive impact on business processes and environment. It is very important that a person has not only understanding of ethical behavior but also the responsibility to set ethical practices in own area of work.

While values are personal preferences or choices, they may sometimes contradict with ethics at his workplace. The values of a person affect behavior and his decision making.

This course is meant to sensitize the student to ethics in profession and motivate them to demonstrate ethical behavior in day to day activities and be aware of ethics in profession.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Demonstrate good values and ethics in the day to day activities and at workplace.

CO-2 Identify a set of values and ethics related to fair professional practice.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (Cos)	Programme Outcomes (Pos)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	3	3	3	3	3	3		
CO-2	3	3	3	3	3	3	3		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by the respective program coordinator at the institute level. As per the latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)				
		Classroom Instruction (CI)		Notional Hours (TW/ Activities+ SL)	Total Hours (CI+TW/ Activities)	Total Credits (C)
		L	T			
2400107	Professional Ethics	01	-	-	01	01

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

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Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment(TA)		Term Work & Self Learning Assessment (TWA)		Lab Assessment(LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400107	Professional Ethics	25	-	-	-	-	-	25

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

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J) Theory Session Outcomes (TSOs) and Units: T2400107

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Define concepts-values and ethics and attitude, development of attitudes *TSO 1b.* Identify situations depicting values such as humanity, honesty, punctuality, respect, peace, empathy *TSO 1c.* Identify situations depicting ethics, healthy competition, integrity, truthfulness,	**Unit-1.0 Values and Ethics in Day to Day Life** 1.1. Values- Definition and examples, Ethics- definition and examples, Concept of attitude and development of attitude 1.2. Importance of values and ethics in day to day activities and at workplace- Ethical ways of communication, environmental considerations in engineering processes, Basic concept of Carbon footprint, ethics at workplace 1.3. Examples of situations depicting values- based decisions and ethical behavior in day to Day life	**CO1**
TSO 2a. Identify the relevance of profession to society and environment *TSO 2b.* Identify the need of values and ethics in profession related activities *TSO 2c.* Identify Ethical conflicts	**Unit-2.0 Values and Ethics in Profession** 2.1 Relevance of profession to society 2.2 ethical principles such as respecting others and ourselves, respecting the rights of others, keeping promises, avoiding unnecessary problems to others, avoiding cheating and dishonesty, showing gratitude towards others and encouraging them to work 2.3 Identification of activities and related ethical and unethical behavior for professional activities in their area of work 2.4 Examples of situations depicting values- based decisions and ethical behavior	**CO1, CO2**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Activities and Self-Learning: Reading books related to values and ethics/Epics/ Daily news and discussions in group

a. Assignments: Preparation for group discussion, panel discussion, role play, case study, seminar, skits

b. Micro Projects: Skits development and performance, poster making,

c. Activities: Role Play, Case studies, Debates, Group Discussion,

d. Suggested Seminar/ Debates on Topics such as:

i. charters of professions
ii. Importance of Values and ethics in identified profession
iii. Issues of ethical conflicts- Professional rivalry,
iv. Identified issues from Chanakya Neeti
v. Ethics in scriptures such as Kabir ke Dohe etc.
vi. Lessons on ethics from religious scriptures
vii. Issued based on Happenings reported in Daily news

L) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Case Method, Group Discussion, seminar, Role Play, Live Demonstrations in Classrooms, Lab, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

M) List of Major Laboratory Equipment, Tools and Software: (Not Applicable)

N) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Professional Ethics and Human Values	D. R. Kiran	McGraw-Hill Education Pvt. Ltd. 2007 ISBN: 9780070633872
2.	A Textbook On Professional Ethics And Human Values	Dr. R S Naagarazan	New Age International (P) Ltd., Publishers, 2017 ISBN: 9789386173768
3.	Ethics, Integrity and Aptitude – **Hindi** (Paperback) (एथिक्स, सत्यनिष्ठा एवं अभिवृत्ति)	P.D Sharma	Rawat Publications, 2019 ISBN: 978-8131609941
4	Chanakya - Niti (Sutra Sahit) (Hindi)	Chanakya	Maple Press. 2014 ISBN 978-9350335529

(b) Online Educational Resources:

1. Free Ethics & Compliance Toolkit - Ethics and Compliance Initiative (https://www.ethics.org/resources/free-toolkit
2. Free & open source tools for ethics practitioners (https://www.cityethics.org/harvard-lab)
3. Microsoft Word - KPTI XII - Indian Ethics 03-05-13 (https://cbseacademic.nic.in/web_material/doc/ktpi/30_KPTI%20XII%20-%20Indian%20Ethics_old.pdfcbseacademic.nic.in)
4. Knowledge Traditions & Practices of India (cbseacademic.nic.in) (ps://cbseacademic.nic.in/web_material/Circulars/2012/68_KTPI/Module_5.pdf)

(c) Others: -

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A) Course Code : **2400008(P2400008/S2400008)**

B) Course Title : Sports, Yoga and Meditation (Common for all Programmes)

C) Pre- requisite Course(s) :

D) Rationale

Sports or Physical Education, Yoga and Meditation is an integral part of a person's overall well-being and is imperative for a healthy mind and body balance. So, it is necessary that every educational institutes should lay ample emphasis on including sports, yoga and meditation as a necessary part of education, however, it depends on how it is introduced in the curriculum makes all the difference. Sports, Yoga and Meditation plays a very important role in overall Well-being for a good personality, develops value system, sense of friendliness, feeling of togetherness thereby developing team spirit and mutual cooperation. Its also plays a major role in reducing level of stress/anxiety and add to the mental toughness. Looking to the ample benefits there is need to inculcate sports, Yoga and meditation as a day to day habit and imparting education related to physical education is more critical than ever before.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Select appropriate physical activities to maintain healthy lifestyle.

CO-2 Apply basic principles and practices of Yoga and meditation for overall growth & development.

CO-3 Use fitness and wellness techniques for optimal health and wellbeing

CO-4 Apply ancient Indian ayurvedic methods and techniques, exercises, yoga and meditation for fitness and wellness.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	3	3	-	1	-	2		
CO-2	3	3	3	-	1	-	2		
CO-3	3	3	3	-	1	-	2		
CO-4	3	2	1	-	1	-	1		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by the respective program coordinator at the institute level. As per the latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400008	Sports, Yoga and Meditation	-	-	01	01	02	01

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400008	Sports, Yoga and Meditation	-	-	10	-	06	09	25

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1a Explain ancient history and development of yoga in India *TSO.1b* Compare the ancient Indian games with the modern games. *TSO.1c* Differentiate between given terms used in sports *TSO.1d* Describe the different aspects of Mental Toughness *TSO.1e* Use Imagery Training for sports *TSO.1f* Apply motivation techniques to motivate students in sports. *TSO.1g* Use concentration techniques for playing and exercising. *TSO.1h* Manage Stress, Anxiety and Arousal during sports. *TSO.1i* Select sports and exercise for healing and developing health and mental wellness *TSO.1j* Describe the impact of parents' involvement in their children's sports activities *TSO.1k* Select sports and exercises for physically challenged as per their need.	**Unit-1.0 Sports and Exercises** 1.1 Historical development of physical activities and sports in India, Indian ancient games- Kho-Kho and Kabaddi, Chariot races, riding elephants and horse, swordsmanship, wrestling, boxing, atyapatya, archery, dancing, dands baithak, malkhamb, lezim, lathi etc 1.2 Origin of traditional sports, 3rd century BCE-martial arts and archery, indoor games like Chess and Snakes & Ladders have origins in ancient India, in the form of games of Chaturanga and Gyan Chauper, 1.3 Dholavira, the world's oldest terraced arena 3000 BC 1.4 Definition of play, game, sports, exercise, psychology, sports psychology and exercise psychology, psychology and common sense. 1.5 Mental toughness- mind, Imagery, use of imagery and imagery in sports, types of imagery (visual, kinesthetic, auditory and olfactory) 1.6 Motivation in sport and goalsetting in sports 1.7 Arousal regulation – self-awareness of regulation, anxiety reduction techniques-somatic anxiety reduction techniques, cognitive Anxiety reduction, multimodal anxiety reduction, coping with stress. Arousal -inducing techniques. Arousal and anxiety measurement factors, Arousal and anxiety signs recognition 1.8 Nutrition and rehabilitation, Importance of concentration and attentional focus in sports and training, Impact of health on healing from physical athletic injuries. Impact of exercise to increase mental wellness, Role of coach in sports, parents' involvement in their children's sports activities. 1.9 Adaptation of sports and exercises for physically challenged students in all levels.	**CO1, CO4**
TSO.2a Explain ancient history and development of yoga in India *TSO.2b* Identify the physiology of yoga and meditation. *TSO.2c* Evaluate meditation and yoga as a healing modality. *TSO.2d* Select asanas and pranayama as per need. *TSO.2e* Describe the effect of yoga and meditation on ageing, stress and hypertension. *TSO.2f* Select mediation techniques as per the need. *TSO.2g* Explain Bandha, Mudra and Chakra *TSO.2h* Enumerate the steps of Suryanamaskar. *TSO.2i* Select Yoga and Meditation for physically challenged as per their need.	**Unit-2.0 Yoga and Meditation** 2.1 Origin of yoga, History and development of yoga, Adi yogi, evidences of yoga in pre-Vedic period (2700 B.C.), Vedic Period, Pre-Classical Period, Classical Period- Patanjali's period, Modern Period. 2.2 Yoga practices and the related literature-Vedas (4), Upanishads (108), Smritis, teachings of Buddhism, Jainism, Panini, Epics (2), Puranas (18) 2.3 Importance of Yoga & Mediation, meaning of the term Yoga and Meditation, Fundamentals Principles of Yoga & Fitness training, Eight Limbs of Yoga 2.4 Difference between yoga asana and physical exercises, Difference between yoga and meditation	**CO2, CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	2.5 Role of Yoga and Meditation in Purificatory Process, in character building, developing concentration, will power and discipline 2.6 Types of Yoga Practices - Asanas, Pranayama, Meditation 2.7 Mindfulness – knowing the mind, training the mind, feeling the mind 2.8 Different Methods of meditation, Physiology of meditation, Mental, physical and emotional benefits of Asanas, Pranayama, Concentration and Meditation 2.9 Bandha, Mudra and Chakra 2.10 Effects of Asanas and pranayama on physiology of human body 2.11 Importance of "Suryanamaskar 2.12 Adaptation of Yoga and meditations for physically challenged students in all levels. 2.13 Yoga Asanas Do's and Don'ts for Beginners	
TSO.3a Explain the ancient Indian ayurvedic methods for fitness and wellness *TSO.3b* Identify the different factors affecting the fitness and wellness in the given situation *TSO.3c* Use different methods to maintain Health and Wellness *TSO.3d* Explain the components of Balance Diet *TSO.3e* Identify the causes of stress and anxiety in the given situation *TSO.3f* Use stress reduction techniques to manage Stress and Anxiety *TSO.3g* Manage Stress, Anxiety and Depression in the given situation *TSO.3h* Select recovery process for energy replenishment after exercise.	**Unit 3.0 Fitness and Wellness** 3.1 Evolution of wellness, 3,000-1,500 BC: Ayurveda –holistic system, Tailored Ayurvedic regimens as per unique constitution of each person (their nutritional, exercise, social interaction and hygiene needs) – with the goal of maintaining a balance that prevents illness. 3.2 Meaning, Importance, Definition and dimensions of Health and Wellness (WHO/Yoga) 3.3 Factors affecting Fitness and Wellness 3.4 Role of Physical Activities and Recreational Games in maintaining physiological and psychological wellbeing. 3.5 Different Methods to Maintain Health, Wellness and to enhance mood 3.6 Nutrition for Health & Wellness, Relationship between Diet and Fitness Components of Balance Diet and its importance – Carbohydrates, Protein, Fat, Vitamins & Minerals, Water, Healthy Lifestyle through Diet and Fitness 3.7 Anxiety, Stress and Aging-Meaning of Anxiety, Stress and Aging, Types and Causes of Stress, 3.8 Stress, anxiety and depression reduction with exercise, yoga and meditation 3.9 Energy Continuum and Recovery Process, Metabolism and exercise, Recovery from exercise, Replenishment of energy stores during recovery process, Removal of excess lactic acid produced during exercise	**CO3, CO4**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400008

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Perform various sports activities for overall growth and development *LSO 1.2.* Select suitable sport activities as per your need.	1.	Track & Field: Running, Jumping, walking and Throwing, Cycling Event to develop Endurance, Speed, Strength, Agility, Flexibility etc	CO1
	2.	Aerobics and Gymnastics to develop Strength, Agility and Flexibility	
	3.	Net/Wall Sports – Volleyball and Basketball to develop Endurance, Speed, Strength, Agility and Flexibility	
	4.	Striking & Fielding sports like Cricket, bowling, Hockey, Football Baseball etc. to develop Endurance, Speed, Strength, Agility, Flexibility and Coordination	
	5.	Racket Game- Tennis, Badminton, Table tennis etc to develop Endurance, Speed, Strength, Agility and Flexibility	
	6.	Outdoor games: Kho-Kho and Kabaddi and cycling develop Endurance, Speed, Strength, Agility and Flexibility	
	7.	Indoor games: Chess and Carrom, Swimming, Boxing, Karate Weightlifting, Power Lifting, Physique Training, Archery, Roller Skating etc to develop concentration.	
	8.	Prepare and organize Adapted Sports for various levels of physically challenged and impairments.	
LSOs 2.1 Perform various yogic techniques for internal purification and development.	9.	Shat Karmas: Tratakam, Jala-Neti, Sutra-Neti, Vamana Dhauti, Danda Dhauti, Agnisara, Nauli	CO2
	10.	Perform following asanas with correct posture: Ardha-Padmasana [virasana], Ardha-Halasana, Pavana-Muktasana, Naukasana, Ardha-shalabhasana, Shalabhasana, Makarasan, Bhujangasana, Dhanurasana	
	11.	Perform following asnas with correct posture: Vakrasana,Chakrasana,Paschimottanasana,Ugrasana,Gomukh asana, Padmasana, Siddhasana, Bhadrasana, Swastikkasana, Vajrasana, Supta-Vajrasana, Yoga-Mudra	
	12.	MUDRAS & SURIYANAMASKAR Brahma-Mudra, Simha-Mudra, Shanmugi Mudra, Viparithakarani-Mudra, Ashwsini-Mudra, Suriyanamaskar	
	13.	BANDHAS: Jalandhara-Bandha, Jihva-Banda, Uddiyana Bandha, Moola-Bandha	
	14.	PRANAYAMAS : Nadi-Shuddhi, Nadi-Shodhana, Suryabhadana, Ujjayi, Bhastrika Pranayama, Bhramari Pranayama, Sitkari , Sitali , Kapalabhati	
	15.	MEDITATION -Silent Meditation	
	16.	MEDITATION – Mantra Meditation	
LSO 3.1. Prepare diet chart for optimal health and wellbeing	17.	Prepare a diet chart for the given sport.	CO3
LSO 3.2. Use health monitoring device	18.	Measure heart rate and heart function with health monitoring device	
	19.	Measure blood sugar and blood pressure	
LSO 3.3. Use different equipment's	20.	Use massage therapy equipment, Hot and cold therapy equipment, Ultrasound therapy equipment	
LSO 3.4. Identify your own threshold and identification level for different taste Stimulations	21.	Determine the taste threshold for three different sensations-sweet salty and sour	
LSO 3.5. Check the given sample for conformance to the standard for moisture content.	22.	Determine the moisture content in the given sample of oil/fat	
LSO 3.6. Purity tests of oils/fats	23.	Determine the impurities in the given sample of oil.	
LSO 3.7. Acidity test in given sample of fat/oil	24.	Determines the acid value and free fatty acids in the given sample of oil/fat.	

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 3.8. Check whether any given samples of oils/fats conform to the standard.	25.	Determine the peroxide value in the given sample of fat or oil.	

L) Suggested Term Work/ Activities and Self Learning: S2400008 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

i. Calculate your Body Composition (BMI) and Cardiovascular Assessment
ii. Assessment for Muscular Endurance, Muscular Strength,
iii. Flexibility, Cardio-respiratory Endurance, Body Composition
iv. Rules and Regulations of different indoor and outdoor games.

b. Micro Projects:

i. Identify and synthesize the factors that influence health in various situations (05 situations). Prepare a report with details of situations and solutions to remove the factors.
ii. Visit different sports club, gyms, and schools and identify various measure taken by them for Fitness and wellness of students/ members
iii. Visit different sports club, gyms, and schools and identify various measure taken by them for Fitness and wellness of physically challenged students/ members
iv. Identify which type of stress, anxiety and depression students are facing and steps and solutions to overcome this.

c. Other Activities:

1. Seminar Topics:
   - Identify the health-related challenges in current time and able to apply the preventive measures.
   - Role of peers, community and media in health and wellbeing in each level
   - Knowledge and skills required to preserve community health and well-being
   - Effect of yoga and meditation in maintaining fitness.
   - Methods to involve physically challenged students /members in all levels in sports, yoga and meditation in community.
   - Counselling techniques to counsel players in matters of handling success and failure.

2. Visits: Visit nearby sports complex, Gyms, stadium etc and prepare a report on hygiene maintenance, medical facilities available, facilities available for physically challenged members, facilities available for old aged members, tools and equipment available and training facilities.

3. Self-Learning Topics:
   - Anatomy and physiology of human being
   - Role of Yoga and Meditation in Purificatory Process, in character building, developing concentration, will power and discipline
   - Mindfulness
   - Different Methods to Maintain Health, Wellness and to enhance mood
   - Diet and Nutrition
   - Metabolic adaptations to exercise
   - Cardio-respiratory changes

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1, CO-4	-	-	35%	35%	35%	35%	35%
CO-2, CO-4	-	-	35%	35%	35%	35%	35%
CO-3, CO-4	-	-	30%	30%	30%	30%	30%
Total Marks	**-**	**-**	**04**	**04**	**02**	**06**	**09**
			10				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: (Not Applicable)

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Track & Field: Running, Jumping, walking and Throwing, Cycling Event to develop Endurance, Speed, Strength, Agility, Flexibility etc	CO1	30	60	10
2.	Aerobics and Gymnastics to develop Strength, Agility and Flexibility		30	60	10
3.	Net/Wall Sports – Volleyball and Basketball to develop Endurance, Speed, Strength, Agility and Flexibility		30	60	10
4.	Striking & Fielding sports like Cricket, bowling, Hockey, Football Baseball etc. to develop Endurance, Speed, Strength, Agility, Flexibility and Coordination		30	60	10
5.	Racket Game- Tennis, Badminton, Table tennis etc to develop Endurance, Speed, Strength, Agility and Flexibility		30	60	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
6.	Outdoor games: Kho-Kho and Kabaddi and cycling develop Endurance, Speed, Strength, Agility and Flexibility		30	60	10
7.	Indoor games: Chess and Carrom, Swimming, Boxing, Karate Weightlifting, Power Lifting, Physique Training, Archery, Roller Skating etc to develop concentration.		30	60	10
8.	Prepare and organize Adapted Sports for various levels of physically challenged and impairments.		30	60	10
9.	Shat Karmas : Tratakam, Jala-Neti, Sutra-Neti, Vamana Dhauti, Danda Dhauti, Agnisara, Nauli	CO2	40	50	10
10.	Perform following asanas with correct posture: Ardha-Padmasana [virasana], Ardha-Halasana, Pavana-Muktasana, Naukasana, Ardha-shalabhasana, Shalabhasana, Makarasan, Bhujangasana, Dhanurasana		40	50	10
11.	Perform following asnas with correct posture: Vakrasana,Chakrasana,Paschimottanasana,Ugrasana,Gomukhasana, Padmasana, Siddhasana, Bhadrasana, Swastikkasana, Vajrasana, Supta-Vajrasana, Yoga-Mudra		40	50	10
12.	MUDRAS & SURIYANAMASKAR Brahma-Mudra, Simha-Mudra, Shanmugi Mudra, Viparithakarani-Mudra, Ashwsini-Mudra, Suriyanamaskar		40	50	10
13.	BANDHAS: Jalandhara-Bandha, Jihva-Banda, Uddiyana Bandha, Moola-Bandha		40	50	10
14.	PRANAYAMAS Nadi-Shuddhi, Nadi-Shodhana, Suryabhadana, Ujjayi, Bhastrika Pranayama, Bhramari Pranayama, Sitkari , Sitali , Kapalabhati		40	50	10
15.	MEDITATION -Silent Meditation		40	50	10
16.	MEDITATION - Mantra Meditation		40	50	10
17.	Prepare a diet chart for the given sport.	CO3	40	50	10
18.	Measure heart rate and heart function with health monitoring device		40	50	10
19.	Measure blood sugar and blood pressure		40	50	10
20.	Use massage therapy equipment, Hot and cold therapy equipment, Ultrasound therapy equipment		40	50	10
21.	Determine the taste threshold for three different sensations-sweet salty and sour		40	50	10
22.	Determine the moisture content in the given sample of oil/fat		40	50	10
23.	Determine the impurities in the given sample of oil.		40	50	10
24.	Determines the acid value and free fatty acids in the given sample of oil/fat.		40	50	10
25.	Determine the peroxide value in the given sample of fat or oil.		40	50	10

Note: -All the above Games can be selected from the list of SGFI/AIU/IOA

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
1.	High end computers for record keeping	Processor Intel Core i7 with Open GL Graphics Card, RAM 32 GB, DDR3/DDR4, HDD 500 GB, Graphics Card NVIDIA OpenGL 4 GB, OS Windows 10	All
2.	Aerobics and Gymnastic	Basic facilities and equipment's – Balance Beams, Gymnastic Ball, Gymnastic Chalk, Gymnastic, Clubs, Flex Floor Systems, High Bars, Hoops, Horizontal Bars, Leotards, Music, Parallel Bar, Pommel Horses, Ribbons, Rings, Ropes, Sigle Bar Trainer, Spotting Blocks, Streamers, Trampoline, Tumble Track, Uneven Bar, Vault, Vault Spring Board Gymnastic Accessories – Chalk, Grips, Wrist Supports, Mat, Tape, Socks Singlets, Pants Shoes, Shorts Aerobics- Resistance bands, Jump rope, Step bench or box, Abdominal wheel, Exercise mat, Gliding discs, dumbbells, fitness trampolines, hoops	2
3.	Striking & Fielding sports	Complete Cricket Kit, Football Kit, Bowling Kit, Hockey Kit	4
4.	Net/Wall Sports	Complete Volley Ball and basketball kit	3
5.	Racket Game	Complete Tennis Kit, Table Tennis Kit and badminton kit	5
6.	Outdoor games	Complete Kho-Kho and Kabaddi and cycling kit	6
7.	Indoor games	Complete Chess kit, Carrom kit, Swimming kit, Boxing kit, Karate kit, Weightlifting kit, Power Lifting kit, Archery kit and Roller-Skating kit	7
8.	Physique Training	Cardio Machines- Treadmills, Elliptical Trainers, Exercise Bikes, Rowing Machines, Indoor Bikes, Vibration Machines, Steppers Recumbents Dumbbells, Multi-Purpose Bench, power rack, Adjustable Dumbbell Set 2 x 3-10 kg, Exercise mat, resistance band, balance trainer	7
9.	Sports and wellbeing equipment's for physically challenged and impairments.	Fusion Wheel – all-in-one portable wheelchair gym, Pedal exerciser, Deluxe hand exerciser, Greeper sports shoelaces, Active Hands, Ramble Tag Guidance Aid, Cat Tongue Grip Tape **Adaptive Cycling**- Straps, Leg/ Foot Adapters, Prosthetics, Steering Dampener, Handlebar Adapters, HANDCYCLING- Wheelchairs, Bike-On Handcycles, Trikes, Racing Wheelchairs, Trikes, Recumbent Bikes, All-terrain Handcycles, Mono Cycling, Hand Bikes - Off-Road, Cross Country, Racing, Downhill **Archery -** Field Tripod and Quad Mounts (Archery & Gun), In-Line Draw-Loc, Mounts (Archery & Gun), Stands (Gun), Mounts (Archery & Gun) Binoculars and Rests (Gun), Crossbows (Archery), Wheelchair Platform Stabilizing Crutch Poles, Dampeners, Crossbows (Archery), Hands free shooting rest (Gun) Bowling: ramp, roll assist **Fitness**: Anti-Gravity Treadmill, LapMat for Wheelchairs, Strike Assist, Adaptive Treadmill	8
10.	Yoga	Yoga Mats, Yoga Rollers, Yoga Blocks, Aero Yoga Clothing Blankets, cloth Straps, Bolsters, Wheels	9-16
11.	Fitness and wellbeing equipment's	Health monitoring devices for overall healt- Personal health monitor for heart health, Blood sugar monitoring device, Wireless blood pressure device, Smart watch to track heart function, Hot and cold therapy equipment, Massage therapy equipment, Ultrasound therapy equipment	18-20
12.	Taste kit -To test three different sensations- sweet salty and sour	Salt solution (%) -0.5, 0.8, 1.0, 1.2, 1.5, Sugar solution (%) - 0.05, 0.5, 0.7, 1.0, 1.2, Citric acid (%) - 0.02, 0.04, 0.1, 0.5, 1.0 Spoons, Bowls, Beakers, Plain distilled water	21

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
13.	Test kit to measure peroxide value in the oil	Reagents: Acetic acid-chloroform solution, Saturated potassium iodide solution, Sodium thiosulphate solution- 0.1 N, Starch solution (1%) Apparatus: Pipette 1ml capacity, Conical flask	25
14.	Test kit to measure acid value and free fatty acids in the oil	Sample of oil/fats namely any refined oil or hydrogenated fat. Reagents - ethyl alcohol (95%), phenolphthalein indicator solution, standard aqueous sodium or potassium hydroxide solution (0.1 N or 0.5 N), Pipette (10 ml), Conical flask	24
15.	Test kit to measure impurities in the oil	Sample of Oil/fat, Oven-electric, maintained at 100 ± 1°C., Desiccator, Weighing balance, Filter paper	23
16.	Test kit to measure moisture content in the oil	Sample of oil/fat, Moisture dish-made of porcelain, silica, glass or aluminum, Oven-electric, maintained at 105 ± 1°C., Desiccator Weighing balance	22

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Practical Applications in Sports Nutrition	Heather Hedrick Fink, Alan E. Mikesky	Jones & Bartlett Learning (2020) ISBN No: 978-1284181340
2.	Massage and Medical Gymnastics,	Lace, M. V.	London: J & A Churchill Ltd. ASIN: B000RY4YB0
3.	ACSM's Guidelines for Exercise Testing and Prescription	Gary Liguori	LWW; (2021) ISBN-13: 978-1975150198
4.	Essentials of Strength Training and Conditioning	Javair Gillett	Human Kinetics, (2021) ISBN-13: 978-1718210868
5.	Practical Applications in Sports Nutrition	Heather Hedrick Fink, Alan E. Mikesky	Jones & Bartlett Learning, (2017) ISBN-13: 978-1284101393
6.	Health Fitness Management	Mike Bates, Mike Spezzano, Guy Danhoff	Human Kinetics, (2019) ISBN-13: 978-1450412230
7.	Yoga for Every Body: A beginner's guide to the practice of yoga postures, breathing exercises and meditation	Luisa Ray, Angus Sutherland	Vital Life Books (2022) ISBN-13: 978-1739737009
8.	Science of Yoga: Understand the Anatomy and Physiology to Perfect Your Practice	Ann Swanson	DK Publisher,)2019(ISBN-13: 978-1465479358
9.	Mudras for Modern Living: 49 inspiring cards to boost your health, enhance your yoga and deepen your meditation Cards	Swami Saradananda	Watkins Publishing (2019) ISBN-13: 978-1786782786
10.	Principles and Methods of Adapted Physical Education & Recreation	Kristi Roth, Laurie Zittel, Jean Pyfer, David Auxter	Jones & Bartlett Learning, (2016) ISBN-13: 978-1284077810
11.	Adapted Physical Education and Sport Sixth Edition	Joseph P. Winnick, David L. Porretta	Human Kinetics, (2016) ISBN-13: 978-1492511533
12.	Counselling Skills in Applied Sport Psychology: Learning How to Counsel	Paul McCarthy, Zoe Moffat	Routledge, (2023) ISBN-13: 978-1032592589
13.	Basic Counselling Skills: A Helper's Manual	Richard Nelson Jones	Sage Publication 2012, New Delhi.
14.	Advancements in Mental Skills Training (ISSP Key Issues in Sport and Exercise Psychology)	Maurizio Bertollo, Edson Filho, Peter Terry	Routledge, (2020) ISBN-13: 978-0367111588
15.	The Relaxation and Stress Reduction Workbook	Martha Davis, Elizabeth Robbins, Matthew McKay, Eshelman MSW	A New Harbinger Self-Help Workbook (2019)
16.	Patanjalis Yoga Sutras	Swami Vivekananda	Fingerprint Publishing (2023) Prakash Books India Pvt Ltd, New Delhi, ISBN-13: 978-9354407017

(b) Online Educational Resources:

1. https://onlinecourses.swayam2.ac.in/aic19_ed28/preview- introduction to Yoga and Applications of Yoga
2. https://onlinecourses.swayam2.ac.in/aic23_ge09/preview- Yoga for Creativity
3. https://onlinecourses.swayam2.ac.in/aic23_ge05/preview- Yoga for concentration
4. https://onlinecourses.swayam2.ac.in/aic23_ge06/preview- yoga for memory development
5. https://onlinecourses.nptel.ac.in/noc21_hs29/preview-Psychology of Stress, Health and Well-being
6. https://onlinecourses.swayam2.ac.in/nce19_sc04/preview- Food Nutrition for Healthy Living - Course – Swayam
7. https://www.classcentral.com/course/swayam-fitness-management-17608- Fitness Management from Swayam
8. https://onlinecourses.swayam2.ac.in/nce19_sc04/preview-Food Nutrition for Healthy Living
9. https://onlinecourses.swayam2.ac.in/cec21_ed02/preview Health Education and Recreation
10. https://onlinecourses.swayam2.ac.in/cec22_ed31/preview Sports Administration and Management

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. https://www.yogajournal.com/yoga-101/philosophy/good-read
2. http://hdl.handle.net/123456789/38171- Yoga Philosophy
3. https://yoga.ayush.gov.in

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