

Curriculum of Diploma Programme
in
Artificial Intelligence



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

**State Board of Technical Education
(SBTE), Bihar**

Semester – IV

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				
2444401	PCC	Theory of Computation	02	01	-	02	05	04
2444402	PCC	Introduction to Artificial Intelligence	03	-	04	02	09	06
2444403	PCC	Introduction to Machine Learning	03	-	04	02	09	06
2418305	BCC	Python Programming	03	-	04	02	09	06
2444405	PCC	Software Engg.	02	01	-	02	05	04
2400006	NRC	Environmental Education and Sustainable Development (Common for All Programmes)	01	-	01	01	03	02
2400408	NRC	Employability Skills Development (Common for All Programmes)	01	-	-	-	01	01
2400009	NRC	Open Educational Resources	01	-	-	-	01	01
Total			16	2	13	11	42	30

Note: Prefix will be added to course code if applicable (T for Theory, 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 - IV 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)	
2444401	PCC	Theory of Computation	30	70	20	30	-	-	150
2444402	PCC	Introduction to Artificial Intelligence	30	70	20	30	20	30	200
2444403	PCC	Introduction to Machine Learning	30	70	20	30	20	30	200
2418305	BCC	Python Programming (CE, CSE, AIML, ME, ME (Auto)., ELX, ELX (R), MIE, FTS, CRE, CHE, TE, CACDDM, GT)	30	70	20	30	20	30	200
2444405	PCC	Software Engg.	30	70	20	30	-	-	150
2400006	NRC	Environmental Education and Sustainable Development (Common for All Programmes)	15	-	10	-	10	15	50
2400408	NRC	Employability Skills Development (Common for All Programmes)	25	-	-	-	-	-	25
2400009	NRC	Open Educational Resources	25						25
Total			215	350	110	150	70	105	1000

Note: Prefix will be added to course code if applicable (T for Theory, 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 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 act

- A) **Course Code** : 2444401(T2444401/S2444401)
 B) **Course Title** : Theory of Computation (CSE, AIML)
 C) **Pre- requisite Course(s)** :
 D) **Rationale** :

Theory of Computation is a broad field of study focused on creating more efficient algorithms and other computational processes. This course equips students with essential theoretical knowledge in areas such as automata theory, formal languages, computability, and complexity theory.

This course prepares students to comprehend the capabilities and limitations of computer systems, enabling them to develop critical thinking and problem-solving skills necessary in algorithm design and computational problem-solving within various engineering domains including artificial intelligence.

- E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of the 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 the classroom/ laboratory/ workshop/ field/ industry.

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

- CO-1** Establish Relationship between grammar and language in the context of Theory of Computation.
CO-2 Apply finite automata, regular expressions, and regular grammar to recognize and generate regular languages.
CO-3 Analyze context-free languages and pushdown automata to determine their equivalence with context-free grammars.
CO-4 Evaluate Turing machines to solve problems considering their capabilities and limitations.
CO-5 Apply Rice's theorem to demonstrate undecidable problems about languages.
CO-6 Transforming one problem into another problem using reduction algorithm.

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	2	1	-	-	1		
CO-3	2	2	2	1	-	-	-		
CO-4	2	2	2	1	-	-	-		
CO-5	2	2	2	-	-	-	-		
CO-6	1	2	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)
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2444401	Theory of computation	30	70	20	30	-	-	150

Legend:

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Note:

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- 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: T2444401

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p>TSO 1a. Explain the fundamental concepts of alphabets, languages, and grammar, and their role in the theory of computation.</p> <p>TSO 1b. Apply productions and derivations to generate and manipulate strings within a given language.</p> <p>TSO 1c. Compare different types of languages based on their grammatical structures and complexities.</p> <p>TSO 1d. Explain the significance and implications of the Chomsky Hierarchy in classifying languages and understanding their computational power.</p>	<p>Unit-1.0 Introduction to Theory of Computation</p> <p>1.1 Alphabet, Languages, and Grammar: - Introduction to Alphabet: Set of Symbols or Characters - Exploration of the languages: Sets of strings - Introduction to grammar: Set of rules, - Structure, and formation of valid strings. Productions and derivations</p> <p>1.2 Productions and Derivations: - Concept of production in the grammar. - Explanation of the derivation to generate a string.</p> <p>1.3 Chomsky Hierarchy of Languages: - Introduction to Chomsky Hierarchy. - Levels of formal language category: Type-3 (Regular), Type-2 (Context-Free), Type-1 (Context-Sensitive), and Type-0 (Unrestricted).</p>	CO-1
<p>TSO 2a. Explain the concept of regular expressions and their role in defining regular languages.</p> <p>TSO 2b. Compare nondeterministic finite automata (NFA) with DFA and establish their equivalence.</p> <p>TSO 2c. Explain the relationship between regular grammars and finite automata and demonstrate their equivalence.</p> <p>TSO 2d. Prove laws related to properties of regular languages, such as closure under union, intersection, and complementation.</p> <p>TSO 2e. Apply the pumping lemma for regular languages to prove the non-regularity of specific languages.</p> <p>TSO 2f. Compare the characteristics of Mealy and Moore Machine.</p>	<p>Unit-2.0 Regular languages and Finite Automata</p> <p>2.1 Regular expressions and languages., Deterministic finite automata (DFA) and equivalence with regular expressions.</p> <p>2.2 Nondeterministic finite automata (NFA) and equivalence with DFA,</p> <p>2.3 Regular grammars and equivalence with finite automata, Properties of regular languages, Pumping lemma for regular languages,</p> <p>2.4 Minimization of finite automata.</p> <p>2.5 Mealy and Moore machine</p>	CO-2
<p>TSO 3a. Explain the concept of context-free grammars (CFG) and their role in defining context-free languages (CFL).</p> <p>TSO 3b. Converts a Chomsky normal form into Greibach Normal Form</p> <p>TSO 3c. Establish the equivalence between nondeterministic pushdown automata (NPDA) and context-free grammars.</p> <p>TSO 3d. Apply the pumping lemma for context-free languages to prove the non-context-freeness of specific languages.</p>	<p>Unit 3.0 Context-Free Languages and Pushdown Automata</p> <p>3.1 Context-free grammars (CFG) and languages (CFL)</p> <p>3.2 Chomsky and Greibach normal forms</p> <p>3.3 Nondeterministic pushdown automata (NPDA) and equivalence with CFG</p> <p>3.4 Parse trees and ambiguity in CFG</p> <p>3.5 Pumping lemma for context-free languages</p> <p>3.6 Deterministic pushdown automata and closure properties of CFLs.</p>	CO-3
<p>TSO 4a. Explain the concept of context-sensitive grammars (CSG) and their role in defining context-sensitive languages (CSL).</p>	<p>Unit 4.0 Context-Sensitive Languages and Turing Machines</p> <p>4.1 Context-sensitive grammars (CSG) and languages</p> <p>4.2 Linear bounded automata (LBA) and</p>	CO-4

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 4b. Analyze equivalence between linear bounded automata (LBA) and context-sensitive grammars. TSO 4c. Explain the basic model of Turing machines (TM) and their computational capabilities with example. TSO 4d. Differentiate between Turing-recognizable (recursively enumerable) and Turing-decidable (recursive) languages. TSO 4e. Establish equivalence of different turning machine variants. TSO 4f. Explain the concept of unrestricted grammars and establish their equivalence with Turing machines. TSO 4g. Explain the role of Turing machines as enumerators in the computation of languages.	4.3 equivalence with context-sensitive grammar The basic model for Turing machines (TMs) 4.4 Turing-recognizable (recursively enumerable) and Turing-decidable (recursive) languages and their closure properties 4.5 Variants of Turing machines, including nondeterministic TMs and equivalence with deterministic TMs 4.6 Unrestricted grammars and equivalence with Turing machines 4.7 TMs as enumerators.	
TSO 5a. Explain the Church-Turing thesis and its significance in defining the concept of computability. TSO 5b. Establish reduction techniques between different languages. TSO 5c. Prove the Rice's theorem of undecidable problems about languages. TSO 5d. Differentiate between the complexity classes P, NP, NP-complete, and NP Hard. TSO 5e. Apply reduction techniques and complexity analysis to classify problems within the P, NP, NP-complete, and NP Hard classes.	Unit 5.0 Undecidability 5.1 Church-Turing thesis and universal Turing machine 5.2 Diagonalization languages and reduction between languages, Reduction Theorem, Properties of Reduction 5.3 Rice's theorem and undecidable problems about languages 5.4 P, NP, NP-complete, and NP Hard class of problems	CO-5 CO-6

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: S2444401** 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. Regular Expression Matcher: Create a program that can match regular expressions against input strings. You can implement this using the Thompson's construction algorithm for NFA from regex.
2. Pushdown Automaton Visualizer: Develop a graphical tool that visualizes the operation of a pushdown automaton (PDA) on input strings. This can help users understand how PDAs process input.
3. Context-Free Grammar Parser: Create a program that parses and validates context-free grammars. Users can input a grammar, and the program should check if it's in the correct format.
4. Comparative Analysis of Complexity Classes: Create an informative chart comparing the complexity classes P, NP, NP-complete, and NP Hard. Include a detailed explanation of each class, examples of problems belonging to each class, and their relationship with each other. Highlight the significance of these complexity classes in understanding the computational difficulty of problems.

b. Other Activities:**1. Seminar Topics:**

- Automata Theory and Applications: Explore the basics of automata theory, its types (finite automata, pushdown automata, Turing machines), and practical applications in computer science.
- Complexity Theory: Investigate the different complexity classes (P, NP, NP-complete, PSPACE, etc.), their relationships, and their implications in solving computational problems efficiently.
- Formal Languages and Grammars: Discuss formal language theory, context-free grammars, regular expressions, and their relevance in programming languages and compiler design.
- Decidability and Undecidability: Explore the concept of decidability, undecidability, and examples of undecidable problems in computer science.
- Reduction Techniques in Computational Complexity: Investigate various reduction techniques, such as polynomial-time reductions and Cook-Levin reductions, and their applications in proving NP-completeness.

2. Self-Learning Topics:

- Non-standard computational models like quantum Turing machines, cellular automata.
- Relationship between computational complexity theory and cryptography.
- Theory of Computation in Machine Learning.

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	20%	20%	20%	-	15%	-	-
CO-2	20%	20%	20%	20%	20%	-	-
CO-3	20%	20%	20%	20%	20%	-	-
CO-4	20%	20%	20%	20%	20%	-	-
CO-5	15%	15%	15%	20%	20%	-	-
CO-6	5%	5%	5%	20%	05%	-	-
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 (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction	9	CO-1	14	4	6	4
Unit-2.0 Regular languages and Finite Automata	10	CO-2	14	4	4	6
Unit 3.0 Context-free languages and pushdown automata	11	CO-3	14	4	4	6
Unit 4.0 Context-sensitive languages and Turing machines	10	CO-4	14	4	6	4
Unit 5.0 Undecidability	8	CO-5 CO-6	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): (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	Theory of Computation (with Formal Languages)	R.B. Patel	2nd Edition", Khanna Book Publishing 2020
2	Elements of the theory of Computation	H.R. Lewis and C.H. Papadimitriou	Second Edition, Pearson Education 2003
3	Automata Theory	K.L.P. Mishra and N. Chandrasekaran	3rd Edition, PHI 2006
4	Introduction to Automata Theory, Languages and Computations	J.E. Hopcroft, R. Motwani and J.D. Ullman	second Edition, Pearson Education 2007

(b) Online Educational Resources:

1. <https://nptel.ac.in/courses/106104028>
2. https://en.wikipedia.org/wiki/Theory_of_computation
3. <https://www.javatpoint.com/automata-tutorial>
4. <https://www.geeksforgeeks.org/theory-of-computation-automata-tutorials/>
5. https://www.tutorialspoint.com/automata_theory/index.htm

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

- A) **Course Code** : 2444402(T2444402/P2444402/S2444402)
 B) **Course Title** : Introduction to Artificial Intelligence
 C) **Pre- requisite Course(s)** : Python Programming
 D) **Rationale** :

Artificial intelligence is the theory and development of computer systems able to perform tasks such as, visual perception, speech recognition, decision-making etc. normally requiring human intelligence. Data analytics gives the basis of developing any artificial intelligence system. The AI has its applications in all domains of Industry, business and services, Research & development and many more.

The Python programming language has several modules to write programs to solve Artificial Intelligence, Machine Learning, Data Analysis problems. Moreover, it has simplified syntax and versatile data structures and functions to speed up the code writing efficiently.

This course provides the basics for Artificial Intelligence problem solving techniques, data analytics and articulates the different dimensions of these areas. This course also provides the students the foundations for data analytics with python. The course explains data science techniques and the various Python programming packages required to prepare data for analysis, perform data analytics and create meaningful data visualization.

- 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** Elaborate the use of Artificial Intelligence for the problem solving as Technological driver.
CO-2 Analyze given data by using NumPy package of Python.
CO-3 Analyze given data by using Pandas package of Python.
CO-4 Visualize given data set using Matplotlib.

- 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	2	2	-	-	-	1		
CO-2	1	2	2	3	-	-	2		
CO-3	1	2	2	3	-	-	2		
CO-4	1	2	2	3	-	-	2		

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

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2444402	Introduction to Artificial Intelligence	03	-	04	02	09	06

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J) Theory Session Outcomes (TSOs) and Units: T2444402

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
<p><i>TSO 1a.</i> Elaborate the applications of Artificial Intelligence</p> <p><i>TSO 1b.</i> Explain various technological drivers of Modern AI</p> <p><i>TSO 1c.</i> Describe Knowledge representation</p> <p><i>TSO 1d.</i> Classify Intelligent agents</p> <p><i>TSO 1e.</i> List the characteristics of agents</p> <p><i>TSO 1f.</i> Apply various search strategies for problem solving</p>	<p>Unit-1.0. Artificial Intelligence</p> <p>1.1 Artificial Intelligence: What is AI?, Types of AI, History of AI, Turing Test, Symbol Systems and the scope of Symbolic AI, Structure of AI, Goals of AI, Importance of AI, Techniques used in AI, Perception, Understanding and Action, Technological drivers of modern AI</p> <p>1.2 Knowledge: Definition, Knowledge Representation, objectives and requirements, practical aspects of representation, Components</p> <p>1.3 Intelligent Agents: Agents and Environments, Properties of environments, characteristics of agents, classification of agents</p> <p>1.4 Problem Solving: Problem Formulation, Goal Formulation, State Space Search, Search Problem, Basic search algorithm, Search Tree, Search strategies—Uninformed and informed search, Breadth First Search, Depth First Search, Best First Search, Constraint Satisfaction Problem (CSP), Back tracking Search, Problem Definitions: N Queen Problem, 8Puzzle Problem, Tic-tac-Toe.</p>	CO-1
<p><i>TSO 2a.</i> Explain Data Analytics and its elements</p> <p><i>TSO 3b.</i> Differentiate Data Analysis and Data Analytics</p> <p><i>TSO 2b.</i> Explain the use of open source data</p> <p><i>TSO 2c.</i> Differentiate Qualitative and Quantitative data analysis</p> <p><i>TSO 2d.</i> Explain procedure to Install NumPy Library</p> <p><i>TSO 2e.</i> Use NumPy library to perform various operations and functions on array</p> <p><i>TSO 2f.</i> Write Programs using NumPy for array manipulations</p>	<p>Unit-2.0 Data Analytics and Computing with NumPy</p> <p>2.1 Data Analytics: Data, Types of Data, Importance of Data, Data Analysis Vs Data Analytics, Types of Data Analytics, Elements of Analytics, Data Analysis Process, Qualitative and Quantitative analyses, Open Source Data.</p> <p>2.2 NumPy Library: Introduction, Installation,</p> <p>2.3 Ndarray: creating an array, intrinsic creation of an array, Data types, basic operations, aggregate functions, Indexing, slicing, Iterating, Conditions and Boolean arrays, Array</p> <p>2.4 Manipulation: Joining, splitting, shape changing, sorting, Structured arrays, Reading and Writing array data on a File.</p>	CO-2
<p><i>TSO 3a.</i> Apply Pandas data structure for data analysis</p> <p><i>TSO 3b.</i> Write Programs using Pandas to perform various operations and functions on series.</p> <p><i>TSO 3c.</i> Perform various operation in a Data Frame columns and rows</p> <p><i>TSO 3d.</i> Write Programme to read and write on CSV, XLS and Text data files</p>	<p>Unit-3.0 Data Analysis with Pandas</p> <p>3.1 Pandas data structures: Series, Declaration, selecting elements, assigning values, Filtering values, operations, mathematical functions, evaluating values, handling missing data, creating series from dictionaries, adding two series.</p> <p>3.2 Data Frame: Defining, selecting elements, assigning values, membership, deleting a column, filtering. Index Objects: Indexing, Re-indexing, Dropping, sorting and ranking,</p>	CO-4

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
<i>TSO 3e.</i> Apply various data cleaning operations and prepare data.	Descriptive Statistics 3.3 Data Loading: Reading and Writing csv, xls, text data files, Data Cleaning and Preparation: Handling missing data, removing duplicates, replacing values, Vectorized String Methods, HierarchicalIndexing, Merging and Combining, Data aggregation and Grouping.	
<i>TSO 4a.</i> Illustrate the use of Matplotlib and PyPlot package for showing plots and images <i>TSO 4b.</i> Customize plots with Colors, Markers, Line Styles, Limits, Tics, Labels, Legends, Grids <i>TSO 4c.</i> Differentiate various charts based on their applications	Unit-4.0 Data Visualization with Matplotlib 4.1 Data Visualization: Introduction to Matplotlib, PyPlot package, Figures and Subplots, showing plots and images 4.2 Customizing Plots: Colors, Markers, Line Styles, Limits, Tics, Labels, Legends, Grids, Annotating with text, Matplotlib Configuration 4.3 Chart types: Line, Bar, stacked bar, box plots, pie chart, Histogram and Density plots, Scatter plot, Saving Plots to a file, Close and clear plots.	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: P2444402

Practical/ Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
<i>LSO 1.1.</i> Use basic data structure using NumPy <i>LSO 1.2.</i> Convert the list and tuple as NumPy array	1.	Basic data structures in NumPy a) Create a List, set, tuple and dictionary which stores the details of a student (roll no, name, dept, branch, percentage of mark) in Python and print the values. b) Conversion of list and tuple as NumPy array.	CO-2
<i>LSO 2.1.</i> Create Arrays in Numpy using different intrinsic methods <i>LSO 2.2.</i> Perform arithmetic operations and mathematical operations using arrange and ones intrinsic method.	2	Arrays in NumPy a) Create arrays using different intrinsic methods (ones, zeros, arange, linspace, indice) and print their values. b) Check the results of arithmetic operations like add(), subtract(), multiply() and divide() with arrays created using arrange and ones intrinsic method. c) Check the results of mathematical operations like exp(), sqrt(), sin(), cos(), log(), dot() on an array created using arrange intrinsic method.	CO-2
<i>LSO 3.1.</i> Apply aggregate functions on data by using Built-in function in Numpy	3	Built-in functions in NumPy. a) Load your class Mark list data from a csv (comma separated value) file into an array. Perform the following operations to inspect your array. Len(), ndim, size, dtype, shape, info() b) Apply the aggregate functions on this data and print the results. (Functions like min(), max(), cumsum(), mean(), median(), corrcoeff(), std())	CO-2
<i>LSO 4.1.</i> Handle multiple arrays by applying various operations on arrays	4	Handling Multiple Arrays a) Create two python NumPy arrays (boys, girls) each with the age of n students in the class.	CO-2

Practical/ Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
		b) Get the common items between two python NumPy arrays. c) Get the positions where elements of two arrays match. d) Remove from one array those items that exist in another. e) Extract all numbers between a given range from a NumPy array.	
LSO 5.1. Apply indexing on the given set of data	5	Indexing in NumPy a) Load your class Mark list data from a csv file into an array. b) Access the mark of a student in a particular subject using indexing techniques. c) Select a subset of 2D array using fancy indexing (indexing using integer arrays)	CO-2
LSO 6.1. Create series using list and dictionary in pandas LSO 6.2. Print different values from series in pandas.	6	Working with a Series using Pandas a) Create a series using list and dictionary. 10b. Create a series using NumPy functions in Pandas. b) Print the index and values of series. c) Print the first and last few rows from the series.	CO-3
LSO 7.1. Perform various operation in a Data Frame rows	7	Working with Data Frame Rows a) Slicing Data Frame using loc and iloc. 11b. Filter multiple rows using isin. b) Select first n rows and last n rows c) Select rows randomly n rows and fraction of rows (use df. sample method) d) Count the number of rows with each unique value of variables e) Select n largest and n smallest values. 11g. Order/sort the rows	CO-3
LSO 8.1. Apply different techniques to merge and combine data	8	Merge and combine data a) Perform the append, concat and combine first operations on Data Frames. b) Apply different types of merge on data. 12c. Use a query method to filter Data Frame c) with multiple conditions.	CO-3
LSO 9.1. Create Linear Plot to identify various relation in the data using Matplotlib LSO 9.2. Create Scatter Plot to identify various relation in the data using Matplotlib	9	a) Consider the Salary dataset, which contains 30 observations consisting of years of working experience and the annual wage. Download the data set from https://www.kaggle.com/rohankayan/years-of-experience-and-salary-dataset . b) Create a linear plot to identify the relationship between years of working experience and the annual wages with suitable title, legend and labels. c) Create a scatter plot to identify the relationship between years of working experience and the annual wages with title, legend and labels. d) Also distinguish between observations that have more than 5 years of working experience and observations that have less than 5 years of working experience by using different colors in one single plot.	CO-4

Practical/ Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 10.1. Use Matplotlib to plot Bar graph by Changing the color of each bar, Change the Edge color, Linewidth and Line style.	10	Consider the Iris dataset, where observations belong to either one of three iris flower classes. Download the data set from https://www.kaggle.com/arshid/iris-flower-dataset a) Visualize the average value for each feature of the Setosa iris class using a bar chart. b) Format the obtained bar graph by Changing the color of each bar, Change the Edge color, Line width and Line style.	CO-4

L) **Suggested Term Work and Self Learning: S2444402** 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. Handling Two-dimensional array in NumPy

Download the data set from

<https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data> <https://www.kaggle.com/arshid/iris-flower-dataset>

- Import iris dataset with numbers and texts keeping the text intact into python NumPy.
- Convert the 1D iris to 2D array (iris2d) by omitting the species text field.
- Find the number and position of missing values in iris2d's sepal_length
- Insert np.nan values at 20 random positions in iris 2d dataset
- Filter the rows of iris2d that has petal_length > 1.5 and sepal_length < 5.0

Expected Outcome (Use various operations on two dimensional arrays in NumPy)

2. Handling missing data and duplicates in Pandas

- Identify rows with missing data (isnull(), notnull()) and replace NA/Null data with a given value.
- Drop rows and columns with any missing data (dropna(), dropna(1))
- Find duplicate values and drop duplicates.
- Fill the missing values using forward filling and backward filling.
- Replace the missing value with new value and write the dataframe to a CSV file in the local directory.

Expected Outcomes (a. Identify missing data, b. Find Duplicates values, c. Write the dataframe to a CSV file in the local directory.)

3. Working with Data Frame Columns

- Create and print a Data Frame.
- Find the descriptive statistics for each column.
- Group the data by the values in a specified column, values in the index.
- Set Index and columns in a Data Frame.
- Rename columns and drop columns
- Select or filter rows based on values in columns.

- g. Select single and multiple columns with specific names

4. Indexing & Sorting in NumPy

- Load your class Mark list data from a csv file into an array.
- Sort the student details based on Total mark.
- Print student details whose total marks is greater than 250 using Boolean indexing.

Expected Outcomes (a. Sort the given set of data, b. Use indexing in an array)

5. Array Slicing in NumPy

- Load your class Mark list data into an array called "marks" to store students roll num, subject marks and result.
- Split all rows and all columns except the last column into an array called "features".
- Split the marks array into 3 equal-sized sub-arrays each for 3 different subject marks.
- Split the last column into an array "label".
- Delete the roll num column from the marks array and insert a new column student name in its place.

Expected Outcome (Use array slicing in Numpy for the given set of data)

6. Consider the Iris dataset, where observations belong to either one of three iris flower classes.

Download the data set from

<https://www.kaggle.com/arshid/iris-flower-dataset>

- Visualize the Histogram for each feature (Sepal Length, Sepal Width, petal Length & petal Width) separately with suitable bin size and color.
- Plot the histograms for all features using subplots to visualize all histograms in one single plot. Save the plot as JPEG file.
- Plot the box plots for all features next to each other in one single plot. Perform 3D printing of plastic casing of inhaler used by Asthma patients and estimate the cost.

Expected Outcomes (a. Plot the Histogram for the various features using subplot, b. Plot the box plots for all features next to each other in one single plot)

c. Other Activities:

1. Lab Activities

- Install Python IDE and important Python Libraries
- Install Anaconda and find the features of Jupyter Notebook.
- Import various module using 'import '
- Use Pip Python package manager.
- Import Libraries and Functions in Python

2. Seminar Topics:

- Technological rivers of modern Artificial Intelligence
- Intelligent Agents and Environments in Artificial Intelligence
- Various Search Strategies
- Python Libraries and Packages used in data Science
- Data Visualization
- Overview of various data set available over Internet

3. Self-Learning Topics:

- Use of AI in Engineering and Technology
- Data Science and Machine Learning
- Problem and Goal Formulation
- Search strategies
- Breadth First Search and Depth First Search
- Back tracking Search
- N Queen and 8 Puzzle Problem

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	30%	30%	30%	25%	25%	--	--
CO-2	25%	25%	25%	25%	25%	35%	35%
CO-3	25%	25%	25%	25%	25%	35%	35%
CO-4	20%	20%	20%	25%	25%	30%	30%
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 (CI) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0. Artificial Intelligence	14	CO-1	21	6	6	9
Unit-2.0. Data Analytics and Computing with NumPy	12	CO-2	17	5	4	8
Unit-3.0. Data Analysis with Pandas	12	CO-3	18	5	5	8
Unit-4.0. Data Visualization with Matplotlib	10	CO-4	14	4	6	4
Total Marks	48	-	70	20	21	29

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.	Basic data structures in NumPy	CO-3	-	90	10
2.	Arrays in NumPy	CO-3	-	90	10
3.	Built-in functions in NumPy.	CO-3	20	70	10
4.	Handling Multiple Arrays	CO-3	20	70	10
5.	Indexing in NumPy	CO-3	-	90	10
6.	Working with a Series using Pandas	CO-4	-	90	10
7.	Working with Data Frame Rows	CO-4	20	70	10
8.	Merge and combine data	CO-4	40	50	10
9.	Consider the Salary dataset, which contains 30 observations consisting of years of working experience and the annual wage.	CO-5	80	10	10
10.	Consider the Iris dataset, where observations belong to either one of three iris flower classes.	CO-5	80	10	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, Group Discussion, Portfolio Based Learning, Live Demonstrations in Classrooms, Lab, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, 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.	Computer Systems	Desktop Computers with multi core (4/8) processor, 16 GB RAM, 1 TB HDD	S. No. 1 to 14
2.	Online Python IDE	https://www.online-python.com/	S. No. 1 to 14
3.	Jupyter Notebook	Download from https://jupyter.org/	S. No. 1 to 14
4.	Pip Python package manager	Download Pip 22.3 From https://pypi.org/project/pip/	S. No. 1 to 14
5.	Various modules, Libraries and Packages	NumPy, Pandas, Matplotlib, PyPlot package	S. No. 1 to 14

R) Suggested Learning Resources:**(a) Books:**

S. No.	Titles	Author (s)	Publisher and Edition with ISBN
1.	Artificial Intelligence Basics - A Non-Technical Introduction	TomTaulli	Apress (2019)
2.	Fundamentals of artificial Intelligence	Chowdhary K. R	Springer 2020
3.	Artificial Intelligence A Modern approach	Stuart J. Russell and Peter Norvig	PrenticeHall 2010, 3 rd Edition
4.	Introduction to Computing and Problem-Solving using Python	E. Balagurusamy	McGraw Hill Education (India)Pvt. Ltd.1 st Edition /2016
8.	Taming Python by Programming	Jeeva ose	Khanna Book Publishing Co(P)Ltd, 2017, Reprinted2019
9.	Python Data Analytics	Fabio Nelli	Apress,2015
10.	Python for Data Analysis: Data Wrangling with Pandas, Numpy, and IPython	Wes McKinney	O'REILLY 2018, Second Edition

(b) Online Educational Resources:

1. NPTEL Web Content- Artificial Intelligence, Prof. P. Mitra, Prof. S. Sarkar, IITKharagpur
URL: <https://nptel.ac.in/courses/106/105/106105078/>
2. <https://www.learnpython.org>
3. www.python.org
4. <https://www.tutorialspoint.com/python>

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:**Data Source:**

- <https://archive.ics.uci.edu/ml/machine-learning-databases/auto-mpg/>
- <https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data>
- <https://www.kaggle.com/arshid/iris-flower-dataset>
- <https://www.kaggle.com/rohankayan/years-of-experience-and-salary-dataset>

- A) **Course Code** : 2444403(T2444403/P2444403/S2444403)
 B) **Course Title** : Introduction to Machine Learning (CSE, AIML)
 C) **Pre- requisite Course(s)** : Introduction to Artificial Intelligence
 D) **Rationale** :

Machine Learning is one of the most important technology these days due to its ability to automate tasks, detect patterns and learn from the data. Machine learning has emerged as a fundamental technology which have diverse applications in all fields of engineering and other diversified area.

This course introduces students to the principles and techniques of machine learning, which built-up a strong foundation in data analysis, pattern recognition, and predictive modeling thus enabling them to leverage its potential in their professional careers.

- 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** Prepare data by performing cleaning, testing training operation for better analysis and judgment.
CO-2 Classify the nature of real-world machine learning problems such as supervised learning, unsupervised learning, and reinforcement learning to solve problems.
CO-3 Apply different classification and regression models on a given dataset on the basis of evaluation matrices.
CO-4 Apply different unsupervised learning models on the basis of evaluation matrices on a given datasets.
CO-5 Implement different dimensionality reduction techniques of machine learning to solve a given problem.

- 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	2	1	-	1	-	-	-		
CO-2	2	2		2	-	-	-		
CO-3	2	2	2	2	-	1	1		
CO-4	2	2	2	2	-	1	1		
CO-5	2	2	-	2	-	-	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 and Learning Scheme:

Course Code	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits (C)
		L	T				
2444403	Introduction to Machine learning	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)	
2444403	Introduction to Machine Learning	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: T2444403

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO1.a Differentiate Artificial intelligence and machine learning TSO1.b Classify given dataset TSO1.c Explain preprocessing processes of data TSO1.d Explain technique of data normalization TSO1.e Split dataset into train, test and validation sets.	Unit-1.0 Introduction to Machine Learning (ML) 1.1 Overview of Artificial Intelligence (AI) Introduction to ML, Relationship between AI & ML, Difference between AI & ML 1.2 Datasets Type of datasets, Text Datasets, Image Datasets, Time Series Datasets, Spatial Datasets, Graph Datasets 1.3 Preprocessing and normalization Data Cleaning, Data Transformation, Feature Encoding, Dimensionality Reduction, Feature Selection, Data Normalization 1.4 Dataset division test, train, and validation sets , Cross-validation.	CO-1
TSO 2a. Explain machine learning process TSO 2b. Discriminate supervised, unsupervised, and reinforcement learning TSO 2c. Describe the real-life machine learning examples.	Unit 2.0 Fundamental Elements of Machine Learning 2.1 Applications of Machine Learning, processes involved in Machine Learning. 2.2 Machine Learning Techniques Supervised Learning, Unsupervised Learning, Reinforcement Learning 2.3 Real life examples of Machine Learning.	CO-2
TSO 3a. Explain the advantages and challenges related to K-nearest neighbor classifier. TSO 3b. Differentiate between linear and logistic regression. TSO 3c. Use different evaluation measures to quantify the variation of data points from a regression line TSO 3d. Evaluate the performance of classification models.	Unit 3.0 Supervised Learning 3.1 Classification and Regression, K-Nearest Neighbor, Linear Regression, Logistic Regression 3.2 Evaluation Measures, Sum of squares error (SSE), Mean squares error (MME), R-square, confusion matrix, precision, recall, F-Score, ROC-Curve	CO-3
TSO 4a. Explain clustering and its challenges. TSO 4b. Differentiate between hierarchical, agglomerative, and divisive clustering. TSO 4c. Differentiate Extrinsic Measures and Intrinsic Measures	Unit 4.0 Unsupervised Learning 4.1 Introduction to Clustering Types of Clustering, Hierarchical, Agglomerative Clustering, Divisive clustering 4.2 Evaluation measures for clustering: Extrinsic Measures, Intrinsic Measures	CO-4
TSO 5a. Explain the need of dimensionality reduction techniques with example. TSO 5b. Differentiate between PCA, LDA, and ICA.	Unit 5.0 Dimensionality Reduction Techniques Principal component Analysis (PCA), Linear discriminant Analysis (LDA), Independent component Analysis (ICA)	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: P2444403

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use pandas library for data analysis. LSO 1.2. Apply normalization techniques on a given dataset. LSO 1.3. Use scikit-learn to split datasets into train, test, and validation sets LSO 1.4. Apply train, test, and validation technique on given dataset	1.	a. Import and export data using Pandas library functions. b. Use standard scalar and minimax normalization techniques on a given dataset. c. Split datasets into train, test, and validation sets. d. Apply k-fold validation technique on a given dataset.	CO-1
LSO 2.1. Write, execute python program to implement k-nearest neighbor classifier. LSO 2.2. Write, execute python program to implement linear regression. LSO 2.3. Write, execute python program to implement logistic regression. LSO 2.4. Apply different performance measures used in python.	2.	a. Implement k-nearest neighbor Classifier using python. b. Implement linear regression using python. c. Implement logistic regression using python. d. Implement various evaluation measures using python.	CO-2, CO-3
LSO 3.1. Write and execute python program to implement K-mean clustering technique. LSO 3.2. Write and execute python program to implement fuzzy C-mean clustering technique.	3.	a. Implement K-mean clustering using python. b. Implement fuzzy C-mean clustering using python.	CO-1, CO-4
LSO 4.1. Write and execute python program to implement Principle Component Analysis (PCA) method. LSO 4.2. Write and execute Python program to implement Linear discriminative analysis (LDA) method.	4.	a. Implement Dimensionality reduction using Principle Component Analysis (PCA) method. b. Implement Dimensionality reduction using the Linear discriminative analysis (LDA) method.	CO-1, CO-5 CO-1, CO-5

L) Suggested Term Work and Self-Learning: S2444403 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 recent classifiers (supervised learning) used in the research/real-time project.
2. Prepare a report on recent clustering techniques (unsupervised learning) used in the research/real-time project.
3. Make a small project on Loan Prediction using Machine Learning on a Kaggle dataset named "Loan Prediction Problem Dataset". The link to the dataset is- <https://www.kaggle.com/datasets/altruistdelhite04/loan-prediction-problem-dataset>.
4. Prepare a presentation on different datasets with their salient points used in classification and clustering from UCI and Kaggle repositories.

c. Seminar Topics:

1. Future of Machine Learning
2. Support vector machine
3. Artificial neural network
4. Deep learning
5. Pros and cons of Machine learning

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 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	20%	20%	20%	20%	20%	20%	20%
CO-2	15%	15%	15%	20%	20%	15%	20%
CO-3	25%	25%	25%	20%	20%	25%	20%
CO-4	25%	25%	25%	20%	20%	25%	20%
CO-5	15%	15%	15%	20%	20%	15%	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 (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Machine Learning (ML)	10	CO1	14	3	5	6
Unit 2.0 Fundamental Elements of Machine Learning	8	CO1, CO2	10	3	2	5
Unit 3.0 Supervised Learning	12	CO3, CO4	18	5	4	9
Unit 4.0 Unsupervised Learning	12	CO3, CO4	18	5	4	9
Unit 5.0 Dimensionality Reduction Techniques	6	CO4, CO5	10	4	2	4
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 (Marks)		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA* (%)	
1.	a. Import and export data using Pandas library functions.	CO-1	45	45	10
	b. Use standard scalar and minimax normalization techniques on a given dataset.	CO-1	35	55	10
	c. Split datasets into train, test, and validation sets.	CO-1	35	55	10
	d. Apply k-fold validation technique on a given dataset.	CO-1	35	55	10
2.	a. Implement k-nearest neighbor Classifier using python.	CO-2, CO-3	35	55	10
	b. Implement linear regression using python.	CO-2, CO-3	35	55	10
	c. Implement logistic regression using python.	CO-2, CO-3	35	55	10
	d. Implement various evaluation measures using python.	CO-2, CO-3	35	55	10
3.	a. Implement K-mean clustering using python.	CO-1, CO-4	35	55	10
	b. Implement fuzzy C-mean clustering using python.	CO-1, CO-4	35	55	10
4.	a. Implement Dimensionality reduction using Principle Component Analysis (PCA) method.	CO-1, CO-5	35	55	10
	b. Implement Dimensionality reduction using the Linear discriminative analysis (LDA) method.	CO-1, CO-4	35	55	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
1	Computer system	Multi core (4/8) CPU, 16 GB RAM, 1 TB HD, A Graphics Processing Unit with 4 GB or more of video RAM is desirable for large data set.	1-12
2	Python	Version 3.10 or above	1-12
3	Anaconda	Generic	1-12
4	scikit-learn, scipy, numpy, pandas, tensorflow	Generic	1-12

R) Suggested Learning Resources:**(a) Books:**

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Machine Learning for Beginners	Harsh Bhasin	BPB Publications, 1st Edition, ISBN-13978-9389845426
2	Understanding Machine Learning: From Theory to Algorithms	Shai Shalev-Shwartz and Shai Ben-David	Cambridge University Press, 1st Edition, ISBN-13:978-1107057135
3	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems	Aurélien Géron	O'Reilly Media, 3rd Edition ISBN-13:978-9355421982
4	Machine Learning: A Probabilistic Perspective	Kevin P. Murphy	The MIT Press, Illustrated edition, ISBN-13 : 978-0262018029
5	Pattern Recognition and Machine Learning	Christopher M. Bishop	Springer New York, NY, 1st Edition ISBN-13: 9780387310732

(b) Online Educational Resources:

1. <https://www.coursera.org/articles/machine-learning-books>
2. <https://www.javatpoint.com/machine-learning>
3. <https://nptel.ac.in/courses/106106139>

(c) Others:

1. Lab Manuals

- A) **Course Code** : 2418305(T2418305/P2418305/S2418305)
- B) **Course Title** : Python Programming
(CE, CSE, AIML, ME, ME (Auto), ELX, ELX (R), MIE, FTS, CRE, CHE, TE, CACDDM, GT, RE)
- C) **Pre- requisite Course(s)** :
- D) **Rationale** :

Python programming has emerged as a popular programming language across wide range of application segments from Scientific to Machine Learning to mobile app development, and so on. Python is a high-level general-purpose programming language.

Because code is automatically compiled to byte code and executed, Python is suitable as a scripting language, Web application implementation language, etc.

In Python there are multiple levels of organizational structure: functions, classes, modules, and packages. These assist in organizing code. An excellent and large example is the Python standard library.

The Object-oriented Python provides a consistent way to use objects: in Python it is easy to implement new object types (called classes in object-oriented programming).

This introductory course to learn basic Python programming features which can be used as building blocks to develop different kind of applications using Python 3.

- 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** Use various data types and operators in formation of expressions.
- CO-2** Write and execute programs using control statements.
- CO-3** Perform relevant operations on Sequence data types
- CO-4** Create functions in modules
- CO-5** Use numpy in writing python programs
- CO-6** Handle data files and exceptions.

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	2	2	1	-	1	-		
CO-3	1	2	2	1	-	1	-		
CO-4	1	2	2	1	-	1	2		
CO-5	1	2	2	1	-	1	-		
CO-6	1	2	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				
2418305	Python Programming	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)	
2418305	Python Programming	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: T2418305

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Differentiate between Procedure Oriented P and Object Oriented Programming approach with example.</p> <p><i>TSO 1b.</i> Use the concept of Lvalue and Rvalue</p> <p><i>TSO 1c.</i> Write python program using various data types and operators</p>	<p>Unit 1.0 Fundamentals of Python Programming Syntax</p> <p>1.1 Introduction to Python Character Set, Python Tokens, Variables, Lvalue and Rvalue Concepts, and the Use of Comments.</p> <p>1.2 Overview of Data Types:</p> <ul style="list-style-type: none"> • Number Types: Integer, Floating Point, Complex • Boolean Type • Sequence Types: String, List, Tuple • None Type • Mapping Type: Dictionary • Distinction between Mutable and Immutable Data Types <p>1.3 Understanding Operators:</p> <ul style="list-style-type: none"> • Arithmetic Operators • Relational Operators • Logical Operators • Assignment Operator • Augmented Assignment Operators • Expressions and Statements • Type Conversion and Input/Output Mechanisms • Precedence of Operators • Expression Evaluation 	CO-1
<p><i>TSO 2a.</i> Write Python program using decision making statements</p> <p><i>TSO 2b.</i> Write Python program using loop structure to solve iterative problems</p>	<p>Unit-2.0 Conditional and Iterative statements</p> <p>2.1 Conditional statements:</p> <ul style="list-style-type: none"> • simple if statement • if- else statemen • if-elif-else statement <p>2.2 Iterative statements:</p> <ul style="list-style-type: none"> • while loop • for loop • range function • break and continue statements • nested loops 	CO-2
<p><i>TSO 3a.</i> Perform various operations on string using string operators and methods</p> <p><i>TSO 3b.</i> Perform various operations on List using list operators and methods</p> <p><i>TSO 3c.</i> Perform various operations on tuples using tuples operators and methods</p> <p><i>TSO 3d.</i> Perform various operations on set using set methods</p>	<p>Unit-3.0 String, List, Tuples, set and Dictionary</p> <p>3.1 String:</p> <ul style="list-style-type: none"> • Indexing • string operations (concatenation, repetition, membership & slicing) • traversing a string using loops • Built-in functions. 	CO-3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 3e.</i> Perform various operations on dictionary using dictionary methods</p>	<p>3.2 Lists:</p> <ul style="list-style-type: none"> • Introduction • Indexing in list • list operations: concatenation, repetition, membership & slicing, traversing a list, built- in list functions, linear search on list of numbers and counting the frequency of elements in a list <p>3.3 Tuples: Creating, initializing, accessing elements, tuple assignment, performing operations on tuples, tuple methods and built-in functions, nested tuples</p> <p>3.4 Set: Creating set, traversing, adding, removing data in set, performing set operations like join, Union intersection, difference</p> <p>3.5 Dictionary: accessing items in a dictionary using keys, mutability of dictionary: adding a new item, modifying an existing item, built-in dictionary functions.</p>	
<p><i>TSO 4a.</i> Create and use user defined functions to implement modular programming approach</p> <p><i>TSO 4b.</i> Differentiate variable scope with example.</p> <p><i>TSO 4c.</i> Import and use Python modules, libraries</p>	<p>Unit-4.0 Python Functions, Modules and packages</p> <p>4.1 Functions: types of function (built- in functions, functions defined in module, user defined functions), creating user defined function, arguments and parameters, default parameters, positional parameters, Lambda functions, returning value, scope of a variable: global scope, local scope</p> <p>4.2 Modules and Packages: Importing module using 'import' Regular Expressions, Exception Handling, PyPI Python Package Index, Pip Python package manager, Importing Libraries and Functions</p>	CO-4
<p><i>TSO 5a.</i> Write simple Python programs using numpy</p> <p><i>TSO 5b.</i> Use Numpy array in python program</p> <p><i>TSO 5c.</i> Use Numpy to solve linear algebra problem.</p>	<p>Unit-5.0 Numpy</p> <p>5.1 Introduction to NumPy</p> <p>5.2 Installation of NumPy</p> <p>5.3 NumPy Arrays:</p> <ul style="list-style-type: none"> • Understanding the NumPy array • The fundamental data structure in NumPy. • Creation of arrays using different methods: np.array(), np.zeros(), np.ones(), etc. • Exploring array attributes like shape, size, and dimensions. <p>5.4 Array Indexing and Slicing:</p> <ul style="list-style-type: none"> • Accessing elements and subarrays in NumPy arrays using indexing and slicing. • Demonstration of the difference between one-dimensional and multi-dimensional array indexing. 	CO-5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	5.5 Array Operations: <ul style="list-style-type: none"> Performing element-wise operations on NumPy arrays. Exploring universal functions (ufuncs) for mathematical operations. 5.6 Linear Algebra with NumPy: <ul style="list-style-type: none"> Introduction to linear algebra operations using NumPy. Matrix multiplication, determinant, inverse, and solving linear equations. 5.7 File input and output with Numpy 5.8 Broadcasting in Numpy	
TSO 6a. Explain different types of Exceptions in python TSO 6b. Write Python programs for exception handling in Python TSO 6c. Differentiate different modes of file opening. TSO 6d. Perform read, Write, Append operations in files	Unit 6: Exception and File Handling in Python 6.1 Exception Handling: syntax errors, exceptions, need of exception handling, user-defined exceptions, raising exceptions, handling exceptions, catching exceptions, Try - except - else clause, Try - finally clause, recovering and continuing with finally, built-in exception classes. 6.2 File Handling: text file and binary file, file types, open and close files, reading and writing text files, reading and writing binary files, file access modes	CO-6

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2418305

Practical/Lab Session Outcomes (LSOs)	S.No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Write, execute and debug simple Python program using Integrated Development and Learning Environment (IDLE) LSO 1.2. Write and execute simple 'C' program using variables, arithmetic expressions.	1.	a) Download and Install IDLE. Write and execute Python program to- b) Calculate the Area of a Triangle where its three sides a, b, c are given. $s=(a+b+c)/2$, Area=square root of $s(s-a)(s-b)(s-c)$ (write program without using function) c) Swap Two Variables d) Solve quadratic equation for real numbers.	CO-1
LSO 2.1. Write and execute python programs using conditional statements. LSO 2.2. Write and execute python programs using various types of Loop statements	2.	Write and execute Python program to- a) Check if a Number is Positive, Negative or zero. b) Check whether the given year is a Leap Year. c) Print all Prime Numbers in an Interval. d) Display the multiplication Table based on the given input. e) Print the Fibonacci sequence.	CO-2

Practical/Lab Session Outcomes (LSOs)	S.No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
		f) Find the Factorial of a Number.	
<i>LSO 3.1.</i> Write and execute Python program to perform various operations on string using string operators and methods	3.	Write and execute Python program to- a) Check whether the string is Palindrome b) Reverse words in a given String in Python c) Identify in a strings the name, position and counting of vowels. d) Count the Number of matching characters in a pair of string (set) e) Python program for removing i-th character from a string	CO-2, CO-3
<i>LSO 4.1.</i> Write and execute Python program to perform various operations on List using List operators and methods	4.	Write and execute Python program to- a) Find largest number in a given list without using max (). b) Find the common numbers from two lists. c) Create a list of even numbers and another list of odd numbers from a given list. d) To find number of occurrences of given number without using built-in methods.	CO-2, CO-3
<i>LSO 5.1.</i> Write and execute Python program to perform various operations on Tuple using Tuple operators and methods.	5.	Write and execute Python program to- a) Find the index of an item of a tuple. b) Find the length of a tuple. c) To reverse a tuple. d) Write a Python program to sort a list of tuple by its float element. Sample data: [('item1', '12.20'), ('item2', '15.10'), ('item3', '24.5')] Expected Output: [('item3', '24.5'), ('item2', '15.10'), ('item1', '12.20')]	CO-2, CO-3
<i>LSO 6.1.</i> Write and execute Python program to perform various operations on sets using set methods.	6.	Write and execute Python program to- a) Create an intersection of sets. b) Create a union of sets. c) Create set difference. d) Check if two given sets have no elements in common.	CO-2, CO-3
<i>LSO 7.1.</i> Write and execute Python program to perform various operations on Dictionary using Dictionary methods	7.	Write and execute Python program to- a) Write a Python script to concatenate two dictionaries to create a new one b) Write a Python script to merge two Python dictionaries. c) Write a Python program to combine two dictionary adding values for common keys. d1 = {'a': 100, 'b': 200, 'c':300} d2 = {'a': 300, 'b': 200, 'd':400} Sample output: d({'a': 400, 'b': 400, 'd': 400, 'c': 300})	CO-2, CO-3

Practical/Lab Session Outcomes (LSOs)	S.No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 8.1.</i> Write and execute Python program to create user defined functions and call them.	8.	Write and execute Python program to- a) Write a Python function for reversing a string and call it. b) Write a Python function for calculating compound interest and call it. c) Write a Python function for calculating the factorial of a number and call it to calculate $\ln/(!r)!(n-r)$ where symbol “! “ stands for factorial.	CO-2, CO-4
<i>LSO 9.1.</i> Write and execute Python program to define a numpy array. <i>LSO 9.2.</i> Develop and execute Python program Using various types of Numpy operation.	9.	a) Write a python program to create a Numpy array filled with all zeros b) Write a python program to check whether a Numpy array contains a specified row c) Write a python program to Remove rows in Numpy array that contains non-numeric values d) Write a python program to Find the number of occurrences of a sequence in a NumPy array e) Write a python program to Find the most frequent value in a NumPy array f) Write a python program to Combine a one and a two-dimensional NumPy Array g) Write a python program to Flatten a Matrix in Python using NumPy h) Write a python program to Interchange two axes of an array	CO-2, CO-5
<i>LSO 10.1.</i> Develop and execute Python program to handle various type of exceptions. <i>LSO 10.2.</i> Develop and execute Python program to perform file operations.	10.	a) Using exception handling feature such as try...except, try finally- write minimum three programs to handle following types of exceptions. i. Type Error ii. Name Error iii. Index Error iv. Key Error v. Value Error vi. IO Error vii. Zero Division Error b) Write Python program to demonstrate file operations.	CO-6, CO-1, CO-2,

Note: in addition to above listed practical, students are suggested to practice all the examples covered by the teacher during theory sessions.

L) **Suggested Term Work and Self Learning: S2418305** 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. Create a shop billing system
2. Create income tax calculation system.
3. Develop number guessing game (random integer will be selected by the system and the user has to guess that integer in the minimum number of guesses. Maximum 5 guess allowed.)
4. Assign numbers to alphabet a-z as (1-26). User will input a word. System will convert it to a number by adding all the individual alphabets of that word.
5. Design a basic calculator program that performs arithmetic operations like addition, subtraction, multiplication, and division based on user input.
6. Any other micro-projects suggested by subject faculty on similar line.

(Students may use file and sequence data types to develop above listed applications)

c. **Other Activities:**

1. Seminar Topics:
 1. Tkinter widgets in python
 2. Python date/time module and its applications
 3. wxPython and its applications

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%	15%	16%	16%	10%	16%
CO-2	15%	15%	15%	16%	16%	15%	16%
CO-3	25%	25%	20%	18%	18%	25%	18%
CO-4	15%	15%	15%	16%	16%	15%	16%
CO-5	25%	25%	25%	18%	18%	25%	18%
CO-6	10%	10%	10%	16%	16%	10%	16%
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 (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Basics of Python Programming syntax	4	CO-1	7	3	2	2
Unit-2.0 Conditional and Iterative statements	6	CO-2	10	3	3	4
Unit-3.0 3.0 String, List, Tuples, set and Dictionary	12	CO-3	18	5	3	10
Unit-4.0 Python Functions, Modules and packages	7	CO-4	10	3	3	4
Unit-5.0 Numpy	12	CO-5	18	4	5	9
Unit-6.0 Exception and File Handling in Python	7	CO-6	7	2	2	3
Total	48	-	70	20	18	32

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 and execute Python program to- a) Calculate the Area of a Triangle where its three sides a,b,c are given. $s=(a+b+c)/2$, Area=square root of $s(s-a)(s-b)(s-c)$ (write program without using function) b) Swap Two Variables c) Solve quadratic equation for real numbers.	CO-1	40	50	10
2.	Write and execute Python program to- a) Check if a Number is Positive, Negative or zero. b) Check whether the given year is a Leap Year. c) Print all Prime Numbers in an Interval. d) Display the multiplication Table based on the given input. e) Print the Fibonacci sequence. f) Find the Factorial of a Number.	CO-2	40	50	10
3.	Write and execute Python program to- a) Check whether the string is Palindrome b) Reverse words in a given String in Python c) Identify in a strings the name, position and counting of vowels. d) Count the Number of matching characters in a pair of string (set) e) Python program for removing i-th character from a string	CO-2, CO3	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
4.	Write and execute Python program to- a) Find largest number in a given list without using max(). b) Find the common numbers from two lists. c) Create a list of even numbers and another list of odd numbers from a given list. d) To find number of occurrences of given number without using built-in methods.	CO-2, CO-3	40	50	10
5.	Write and execute Python program to- a) Find the index of an item of a tuple. b) Find the length of a tuple. c) To reverse a tuple. d) Write a Python program to sort a list of tuple by its float element. Sample data: [('item1', '12.20'), ('item2', '15.10'), ('item3', '24.5')] Expected Output: [('item3', '24.5'), ('item2', '15.10'), ('item1', '12.20')]	CO-2, CO-3	40	50	10
6.	Write and execute Python program to- a) Create an intersection of sets. b) Create a union of sets. c) Create set difference. d) Check if two given sets have no elements in common.	CO-2, CO-3	40	50	10
7.	Write and execute Python program to- a) Write a Python script to concatenate two dictionaries to create a new one b) Write a Python script to merge two Python dictionaries. c) Write a Python program to combine two dictionary adding values for common keys. d1 = {'a': 100, 'b': 200, 'c':300} d2 = {'a': 300, 'b': 200, 'd':400} Sample output: d({'a': 400, 'b': 400, 'd': 400, 'c': 300})	CO-2, CO-3	40	50	10
8.	Write and execute Python program to- a) Write a Python function for reversing a string and call it. b) Write a Python function for calculating compound interest and call it. c) Write a Python function for calculating the factorial of a number and call it to calculate $n!/r*(n-r)$ where symbol “! “ stands for factorial.	CO-2, CO-4	40	50	10
9.	a) Write a python program to create a Numpy array filled with all zeros b) Write a python program to check whether a Numpy array contains a specified row c) Write a python program to Remove rows in Numpy array that contains non-numeric values d) Write a python program to Find the number of occurrences of a sequence in a NumPy array e) Write a python program to Find the most frequent value in a NumPy array f) Write a python program to Combine a one and a two-dimensional NumPy Array	CO-2, CO-5	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
	g) Write a python program to Flatten a Matrix in Python using NumPy Write a python program to Interchange two axes of an array				
h)	Using exception handling feature such as try...except, try finally- write minimum three programs to handle following types of exceptions. viii. TypeError ix. NameError x. IndexError xi. KeyError xii. ValueError xiii. IOError xiv. ZeroDivisionError	CO-2, CO-6	40	50	10
i)	Write and execute Python program to- a) Calculate the Area of a Triangle where its three sides a,b,c are given. $s=(a+b+c)/2$, Area=square root of $s(s-a)(s-b)(s-c)$ (write program without using function) b) Swap Two Variables c) Solve quadratic equation for real numbers.	CO-1	40	50	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
1.	Computer system	Processor Intel Core i5, 4 GB RAM, 15 GB free disk space	All
2.	Integrated Development and Learning Environment (IDLE)	S/w to be downloaded for python 3.11.3 or higher	All

R) Suggested Learning Resources:**(a) Books:**

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Introduction to Computing and Problem-Solving using Python	E. Balagurusamy	McGraw Hill Education (India) Pvt. Ltd. 1 st Edition /2016
2.	Learning Python Programming	Jeffrey Elkner, Allan B.Downey, Chris Meyers	Samurai Media Limited. 2016
3.	Python Programming	Ashok Namdev Kamthane and Amit Ashok Kamthane	McGraw Hill Education (India) Pvt.Ltd.2020, 2 nd Edition
4.	Programming in Python	Dr. Pooja Sharma	BPB Publications 2017

(b) Online Educational Resources:

1. <https://docs.python.org/3/tutorial/>
2. <https://www.w3schools.com/python/>
3. <https://www.tutorialspoint.com/python/index.htm>

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

- A) **Course Code** : 2444405(T2444405/S2444405)
 B) **Course Title** : Software Engineering
 C) **Pre- requisite Course(s)** :
 D) **Rationale** :

Software Engineering is a systematic approach for software design, development, testing and maintenance by incorporating principles, techniques, and practices. Furthermore, software engineering helps to manage the costs, risks and schedule of the software development process. The goal of software engineering is to produce software that is efficient, easy to use, and maintain so as to fulfil the current and futuristic requirement of the user.

Through this course, student can develop abilities to build a framework to construct good quality software products and ensuring their reliability. Also, students can combine their domain-specific expertise with programming abilities to create superior software products.

- 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** Choose suitable Software process model for software development.
CO-2 Prepare software requirement specifications (SRS) for a given problem.
CO-3 Construct data designs using different software models.
CO-4 Evaluate size and cost of software product.
CO-5 Plan software testing for quality assurance
CO-6 Prepare plan to schedule and track the progress of a given project using project management 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	1	-	-	-	-	-	1		
CO-2	1	2	1	1	-	-	1		
CO-3	2	2	1	1	-	-	-		
CO-4	1	2	1	1	-	-	-		
CO-5	2	1	2	1	-	-	1		
CO-6	1	1	2	2	-	2	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				
2444405	Software Engineering	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)	
2444405	Software Engineering	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.

H) **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: T2444405

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
<p><i>TSO 1a.</i> Identify the attributes that matches with standards for the given software application.</p> <p><i>TSO 1b.</i> Suggest the relevant software solution for the given problem with justification.</p> <p><i>TSO 1c.</i> Select the relevant software process model for the given problem statement.</p> <p><i>TSO 1d.</i> Select the relevant activities in agile development process in the given situation.</p>	<p>Unit-1.0 Software Development Process</p> <p>1.1 Type of software, need for software engineering, software engineering as layered approach, its characteristics.</p> <p>1.2 Software development frame work.</p> <p>1.3 Software process framework, process models: perspective process models, specialized process models.</p> <p>1.4 Agile software development: agile process and its importance, extreme programming, adaptive software development, scrum, dynamics system development method (DSDM), crystal</p> <p>1.5 Selection criteria for software process model.</p>	CO-1
<p>TSO.2.a Apply the principles of software engineering for the given problem</p> <p>TSO.2.b Analyze software requirement by following requirement engineering steps for the given problem.</p> <p>TSO.2.c Represent the requirement engineering model for the given problem</p> <p>TSO.2.d Prepare SRS for the given problem.</p>	<p>Unit 2.0 Software Requirement Engineering</p> <p>2.1 Software engineering practices and its importance, core Principles.</p> <p>2.2 Communication practices, planning practices, modeling Practices. Construction practices, software deployment (Statement and meaning of each Principles for each practice).</p> <p>2.3 Requirement Engineering: Requirement gathering and Analysis, type of requirement (functional, product, organizational, external requirements) Electing requirements models, developing use cases building requirements models, requirement negotiation, validation.</p> <p>2.4 Software Requirements Specification(SRS): need of SRS, Format, and its characteristic</p>	CO-2
<p><i>TSO 3a.</i> Identify the elements of analysis model for the given software requirements.</p> <p><i>TSO 3b.</i> Apply the specified design feature for software requirements modeling.</p> <p><i>TSO 3c.</i> Represent the specified problem in the given design notation.</p>	<p>Unit 3.0 Software Modeling and Design</p> <p>3.1 Translating requirement model into design model: data Modelling.</p> <p>3.2 Analysis Modelling: Elements of Analysis model.</p> <p>3.3 Design modelling: Fundamental design concept (Abstraction, Information hiding, structure, modularity, concurrency, verification, Aesthetics)</p> <p>3.4 Design notations: Data Flow Diagram (DFD), Structure Flowcharts, Decision Tables.</p>	CO-3
<p><i>TSO 4a.</i> Estimate the size of the software product using the given method.</p> <p><i>TSO 4b.</i> Estimate the cost of the software product using the given empirical method.</p> <p><i>TSO 4c.</i> Evaluate the size of the given software using COCOMO model.</p> <p><i>TSO 4d.</i> Apply the RMMM strategy in identified risks for the given software development problem.</p>	<p>Unit-4.0 Software Project Estimation</p> <p>4.1 The management spectrum-4P's</p> <p>4.2 Metrics for size Estimation: Line of Code (LoC), Function Points (FP).</p> <p>4.3 Project cost Estimation Approaches: Overview of Heuristic, Analytical, and Empirical Estimation.</p> <p>4.4 COCOMO (Constructive Cost Model), COCOMO II.</p>	CO-4

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
	4.5 Risk Management: Risk Identification, Risk Assessment, Risk Containment, RMMM Strategy.	
<p><i>TSO 5a.</i> Explain the given characteristic of software testing.</p> <p><i>TSO 5b.</i> Prepare test cases for the given problem.</p> <p><i>TSO 5c.</i> Analyze the test cases for a given problem.</p> <p><i>TSO 5d.</i> Describe the given Software Quality Assurance (SQA) activity.</p> <p><i>TSO 5e.</i> Describe the features of the given software quality evaluation standard.</p>	<p>Unit 5.0 Software Testing and Quality Assurance:</p> <p>5.1 Testing-Meaning and purpose, testing methods- Black- box and White box, level of testing-Unit testing.</p> <p>5.2 Test Documentation- Test case Template, test plan, Introduction to defect Report, test summary report.</p> <p>5.3 Test planning and management: Test Strategy, Test Plan, Test Estimation, Test Case Design, Test Data Preparation, Test Progress Monitoring and Reporting.</p> <p>5.4 Software Quality Management vs. Software Quality Assurance. Phases of Software Quality Assurance: Planning, Activities Audit, and review.</p> <p>5.5 Quality Evaluation standards: Six sigma, ISO for software, CMMI: Levels, process areas.</p>	CO-5
<p><i>TSO.6a</i> Use the given scheduling technique for the identified project.</p> <p><i>TSO.6b</i> Draw the activity network for the given task.</p> <p><i>TSO.6c</i> Prepare the timeline chart/Gantt chart to track progress of the given project.</p>	<p>Unit 6.0 Software Project Management</p> <p>6.1 Overview of project management activities, tasks, resources, Project Scheduling: Basic principle work breakdown structure, activity network and critical path method, scheduling Techniques (CPM, PERT).</p> <p>6.2 Project Tracking; Timeline Charts. Earned value analysis, Gantt charts.</p>	CO-6

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: S2444405

- a. **Assignments:** Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.
- b. **Micro Projects:**
 - a. Study and analyze given software and write characteristics and function of the same.
 - b. Choose any problem statement and use data models to represent the situation
 - I. Search and utilize different UML tools to represent models.
 - c. Choose a problem create activity network and use different project scheduling and tracking tools for the same.
 - d. Apply any testing tools (Selenium, JUnit, etc.) to ensure test cover, defect detection, test management, and Test Execution and Reporting for given problem.
 - e. Apply any project management tool (Microproject Project, Jira work management, etc.) to performs Project planning, Task management, Collaboration and Communication, Time tracking, Resources management, and Gantt Charts and Timelines for given problem.

c. Other Activities:

1. Seminar Topics:

- Software development life cycle Models
- Software Development Ethics: (Address ethical considerations in software engineering, such as data privacy, responsible AI, and the impact of technology on society)
- Principles, methodologies, and best practices of Agile software development
- Software Testing Strategies: (various software testing techniques, including manual testing, automated testing, and exploratory testing, and their significance in delivering quality software)
- Challenges in Software Engineering

2. Self-Learning Topics:

- Different stages of the SDLC
- Techniques for improving code quality, such as code reviews, refactoring, and code analysis tools.
- Software testing techniques, such as unit testing, integration testing, and acceptance testing.

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%	-	17%	--	-
CO-2	20%	20%	20%	20%	17%	-	-
CO-3	20%	20%	20%	20%	17%	-	-
CO-4	20%	20%	15%	20%	17%	-	-
CO-5	15%	15%	15%	20%	16%	-	-
CO-6	10%	10%	15%	20%	16%	-	-
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)

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 (R)	Understanding (U)	Application & above (A)
Unit-1.0 Software Development Process	6	CO-1	09	3	3	3
Unit 2.0 Software Requirement Engineering	9	CO-2	14	4	4	6
Unit 3.0 Software Modeling and Design	10	CO-3	14	4	4	6
Unit 4.0 Software Project Estimation	9	CO-4	14	4	4	6
Unit 5.0 Software Testing and Quality Assurance	7	CO-5	10	3	3	4
Unit 6.0 Software Project Management	7	CO-6	09	2	3	4
Total	48	-	70	20	21	29

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	Software Engineering concepts	Fairly, Richard	McGraw Hill higher education, new Delhi - 2001, ISBN-13: 9780074631218
2	Software Engineering: A practitioner's approach	Pressman, Roger S.	McGraw Hill higher education, new Delhi, (Seventh Edition) ISBN : 978-0-07-337597-7
3	Software Engineering principles and practices	Jain, Deepak	Oxford university press, New Delhi, ISBN :9780195694840
4	Fundamentals of Software Engineering	Rajib Mall	Prentice Hall India Learning Private Limited, ISBN-13: 978-8120348981

(b) **Online Educational Resources:**

- https://www.tutorialspoint.com/software_engineering/index.htm
- <https://www.goskills.com/Project-Management/Resources/How-to-create-a-project-management-plan>
- <https://www.javatpoint.com/software-testing-tutorial>
- <https://www.codingninjas.com/studio/library/software-engineering>

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** : 2400006(T2400006/S2400006)
- B) **Course Title** : Environmental Education and Sustainable Development
(Common for all Programmes)
- C) **Pre- requisite Course(s)** :
- D) **Rationale** :

Every creature depends on nature for their survival. It is therefore, not only essential but also moral responsibility of all of us to keep our environment clean & in a good condition. The global environmental issues such as clean water and sanitation, affordable & clean energy, sustainable cities & communities, etc. are best addresses through sustainable development goals. Environmental education is one of the primary activities to spread the concept of sustainability on a broader scope. In India, environmental education is considered as mandatory for all segment of education including technical education. Every creature depends on nature for their survival. It is therefore, not only essential but also moral responsibility of all of us to keep our environment clean & in a good condition. The concept of sustainable development is closely associated with environmental education to promote developments. Considering importance of environmental education and sustainable development, it became necessary to provide basics of these areas to the engineering graduates. The knowledge gained through this course will help the diploma students to take engineering decisions aligned to ensure sustainability of environment for next generations through proper protection of environment.

- 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** Explain the importance of ecosystem for the protection of environment
- CO-2** Use relevant air & water pollution control methods to solve pollution related issues
- CO-3** Recognize relevant energy sources required for domestic & industrial application
- CO-4** Analyze the issues of climate change and its impact on sustainability
- CO-5** Apply engineering solutions/methods/legislations to reduce the activities that are harming the environment.

- 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	-	2		
CO-2	3	2	2	2	2	-	2		
CO-3	3	-	-	-	3	-	2		
CO-4	3	3	-	2	2	-	2		
CO-5	3	-	3	3	2	2	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				
2400006	Environmental Education and Sustainable Development	01	-	01	01	03	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)	
2400006	Environmental Education and Sustainable Development	15	-	10	-	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) 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: T2400006

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Differentiate aquatic & terrestrial ecosystem</p> <p><i>TSO 1b.</i> Explain structure of ecosystem</p> <p><i>TSO 1c.</i> Compare food chain & web chain</p> <p><i>TSO 1d.</i> Describe carbon, nitrogen, Sulphur & phosphorus cycle</p> <p><i>TSO 1e.</i> Explain causes & effect of global warming</p>	<p>Unit-1.0 Ecosystem</p> <p>1.1 Aquatic & Terrestrial ecosystem</p> <p>1.2 Structure of ecosystem</p> <p>1.3 Food chain & Food web</p> <p>1.4 Carbon, Nitrogen, Sulphur & Phosphorous Cycle</p> <p>1.5 Global warming – Causes & Effects</p>	CO1
<p><i>TSO 2a.</i> Explain environmental pollution & its sources.</p> <p><i>TSO 2b.</i> Assess the causes of water & air pollution in a given area</p> <p><i>TSO 2c.</i> Explain the effects of water & air pollution on human, plant & animal</p> <p><i>TSO 2d.</i> Take appropriate measures to prevent the pollution problems at city /municipal areas</p> <p><i>TSO 2e.</i> Determine the pollution level in the environment at different seasons.</p>	<p>Unit-2.0 Air & Water Pollution</p> <p>2.1 Traditional pollution issues- Air, Water, Noise</p> <p>2.2 Water pollution</p> <p>2.2.1 Sources of water pollution</p> <p>2.2.2 Effects of water pollution</p> <p>2.2.3 Control of water pollution</p> <p>2.2.4 Physical & chemical standard of domestic water as per Indian Standard</p> <p>2.3 Air pollution</p> <p>2.3.1 Sources of air pollution</p> <p>2.3.2 Air pollutants</p> <p>2.3.3 Effects of air pollution on human, plant & animal</p> <p>2.3.4 Air monitoring system</p> <p>2.3.5 Air pollution control</p>	CO2
<p><i>TSO 3a.</i> Describe various types renewable sources of energy</p> <p><i>TSO 3b.</i> Explain solar energy & methods of harnessing</p> <p><i>TSO 3c.</i> Explain wind energy and its impact on environment</p> <p><i>TSO 3d.</i> Explain characteristics of biomass & its digestion process</p> <p><i>TSO 3e.</i> Describe new energy sources & their application</p>	<p>Unit-3.0 Sustainability & Renewable Sources of Energy</p> <p>3.1 Concept of sustainable development</p> <p>3.2 Renewable sources of energy for sustainable development</p> <p>3.3 Solar Energy</p> <p>3.3.1 Features of solar thermal & PV system</p> <p>3.3.2 Solar pond, Solar water heater, Solar dryer and Solar stills</p> <p>3.4 Wind Energy</p> <p>3.4.1 Current status & future prospects of wind energy</p> <p>3.4.2 Wind energy in India- Advantages and challenges of harnessing wind energy</p> <p>3.4.3 Environmental benefits & limitations</p> <p>3.5 Biomass</p> <p>3.5.1 Types of Biomass energy sources</p> <p>3.5.2 Energy content in Biomass of different types</p> <p>3.5.3 Biogas production</p>	CO3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	3.6 Concept and advantages of hydroponics or aquaponics system to demonstrate soil less cultivation and integration of fish and plant cultivation. 3.7 Water conservation and sustainable development 3.8 New Energy Sources: Hydrogen energy, Ocean energy & Tidal energy	
<i>TSO 4a.</i> Describe impact of climate change on human life <i>TSO 4b.</i> Identify the factors contributing to climate change <i>TSO 4c.</i> Explain sustainable development goals to transform the world <i>TSO 4d.</i> Develop implementation strategies for action plan on climate change	Unit-4.0 Climate Change and Sustainable Development 4.1 Impact of Climate change 4.2 Factor contributing to climate change 4.3 Sustainable development Goals (SDGs) 4.4 Action Plan on Climate Change- India	CO4
<i>TSO 5a.</i> Identify the elements of a successful management system <i>TSO 5b.</i> Explain green building concept & its benefits <i>TSO 5c.</i> Apply 5R concept in a given building construction project <i>TSO 5d.</i> Explain various environment protection laws <i>TSO 5e.</i> Explain carbon foot-print & carbon credit	Unit-5.0 Environmental legislation and Sustainable Building Practices 5.1 Environment management system and Planning 5.2 Green Building concept 5.3 Green and sustainable building materials - 5R concept 5.4 Environment protection acts, legislation and Laws 5.5 Zero carbon foot-print building for sustainable construction.	CO5

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

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

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 1.1.</i> Use of Air pollutant analyzer to determine the air pollution level <i>LSO 1.2.</i> Collect air samples for pollution level detection	1.	Determination of air pollutants harming local environment	CO2
<i>LSO 2.1</i> Use of Water pollutant analyzer to determine the water pollution <i>LSO 2.2</i> Collect water samples for pollution level detection	2	Determine the water pollutants harming local environment	CO2
<i>LSO 3.1</i> Prepare report on EIA of a given context and area. <i>LSO 3.2</i> Collection of stakeholders view on effect on environment about a particular project/activity.	3.	Carry out the Environmental Impact Assessment (EIA) for a given project /activity of development	CO1 CO3
<i>LSO 4.1</i> Predict of possible factors causing effects of climate change <i>LSO 4.2</i> Effect of Ice melting on sea water	4.	Assessment of the impact of climate change on local environment	CO1 CO4
<i>LSO 5.1</i> Elaborate the uses of sustainable building materials, the considering 3R	5.	Demonstration of sustainable building materials in lab/workshop	CO2 CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 5.2 Trace of Carbon foot print due to construction of a small building			
LSO 6.1 Set up sample recycling bins in the laboratory LSO 6.2 Appreciate the importance of recycling and environmental benefits LSO 6.3 Explain the importance of 3 R	6.	Demonstration of the recycling process for the different materials such as paper, plastic etc. for waste management	CO3
LSO 7.1 Explain the process of composting LSO 7.2 disseminate the use of composting process to near and dear for soil health and fertility for generating organic food	7	Setting up composting bins in the laboratory to demonstrate the process of composting organic waste	CO3
LSO 8.1 Calculate own water footprint for daily activities LSO 8.2 Explain the importance of reducing water consumption and conserve water resources.	8	Calculation of personal water footprint for daily water usage for activities like bathing, cooking and laundry.	CO3
LSO 9.1 Explore the alternative / renewable sources of energy in day to day life	9.	Develop bio mass energy in the laboratory	CO3 CO4
LSO 10.1 Explore the alternative / renewable sources of energy in day to day life	10.	Develop solar model in the laboratory	CO3
LSO 11.1 Explore the alternative / renewable sources of energy in day to day life	11.	Develop wind turbine model in the laboratory	CO4

L) **Suggested Term Work and Self Learning: S2400006** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

1. Conduct a waste audit in your polytechnic. Categorize waste into different types such as plastic, paper, organic. Quantify the amount of each waste.

b. **Micro Projects:**

- Conduct of EIA of a project/activity such as construction of roads in the local area. Prepare a report on:
 - (a) Environmental issues in your city
 - (b) SDGs and environment related acts/laws applicable in your state and in India.
 - (c) Current-status & future-prospects of Wind Energy
 - (d) New energy sources
- Prepare a model of rain water harvesting system to demonstrate how rainwater can be collected and stored for various purposes such as irrigation and toilet flushing.
- Students may be asked in group to set up a small solar panel to compare the energy output under different lighting condition and angles to understand the concept of solar energy and its potential applications.

c. Other Activities:

1. Seminar Topics:

- Climate change issue and problems
- Sustainable development- Global practices
- Factor affecting sustainability in India

2. Visits:

Visit Pollution control Board of your city. Prepare report of visit with special comments of initiatives taken for protecting environment and ensuring sustainable development of the city.

Organize a field trip to a nearby park for the students. Students can be observed different species of the plants, animals and insects. They may be asked to prepare report on importance of biodiversity conservation.

3. Self-Learning Topics:

- Sustainable Development Goals
- Climate change.
- Pollution issues
- Laws and legislation of environmental protection

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%	-	-	20%	20%
CO-2	-	-	10%	25%	-	10%	20%
CO-3	-	-	15%	25%	50%	15%	20%
CO-4	-	-	30%	50%	50%	15%	20%
CO-5	-	-	30%	-	-	40%	20%
Total Marks	-	-	10	10	05	10	15
			25				

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.	Determine the Air and water pollutants harming local environment	CO1	30	60	10
2.	Determine the water pollutants harming local environment	CO1	40	50	10
3.	Carry out the Assessment of Environmental Impact (EIA) for a given project /activity of development	CO1 CO3	30	60	10
4.	Assess the impact of climate change on local environment	CO1 CO4	30	60	10
5.	Demonstrate sustainable building materials in lab/workshop	CO2 CO5	30	60	10
6.	Demonstrate the recycling process for the different materials such as paper, plastic etc. for waste management	CO3	50	40	10
7.	Setting up composting bins in the laboratory to demonstrate the process of composting organic waste	CO3	50	40	10
8.	Calculation of personal water footprint for daily water usage for activities like bathing, cooking and laundry.	CO3	50	40	10
9.	Develop bio mass energy in the laboratory	CO3 CO4	30	60	10
10.	Develop solar model in the laboratory	CO3	30	60	10
11.	Develop Wind turbine model in the laboratory	CO4	40	50	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
1.	Air analyzer	Air Quality Meter Product Type: Measuring Instrument Analysis Time: 2 sec to 8-hour 59 min. 59 sec Automation Grade: Automatic	1
2.	Water Analyzer	Multi-Parameter Water Testing Meter Digital LCD Multi-Function Water Quality Monitor PH/EC/TDS/Salt/S. G/CF/ORP	2
3.	Sustainable Building Materials	As per availability in the market	2,5

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
4.	Solar energy Panel – KT	Solar Panel Kit 5 LEDs, 2 ON/Off Switch, Wire, 2 Crocodile Clip	7
5.	Bio mass/energy installation -kit	The Bio-energy Science Kit is a great way to find out how a direct ethanol fuel cell works.	6
6.	Wind power energy -Kit	4M wind turbine kit, to demonstrate power of wind and convert it into electricity by building your own turbine.	8
7.	Ice melting demo kit	Simple bowls of different sizes	--

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Ecology and Control of the Natural Environment	Izrael, Y.A.	Kluwer Academic Publisher eBook ISBN: 978-94-011-3390-6
2.	Renewable Energy Sources and Emerging Technologies	Kothari, D.P. Singal, K.C., Ranjan, Rakesh	PHI Learning, New Delhi, 2009 ISBN-13 - 978-8120344709
3.	Green Technologies and Environmental Sustainability	Singh, Ritu, Kumar, Sanjeev	Springer International Publishing, 2017 eBook ISBN 978-3-319-50654-8
4.	Coping with Natural Hazards: Indian Context	K. S. Valadia	Orient Longman ISBN-10: 8125027351 ISBN-13: 978-8125027355
5.	Introduction to Engineering and Environment	Edward S. Rubin	Mc Graw Hill Publications ISBN-10: 0071181857 ISBN-13: 978-0071181853
6.	Environmental Science	Subrat Roy	Khanna Book Publishing Co. (P) Ltd. ISBN-978: 93-91505-65-3

(b) Online Educational Resources:

1. http://www1.eere.energy.gov/wind/wind_animation.html
2. http://www.nrel.gov/learning/re_solar.html
3. http://www.nrel.gov/learning/re_biomass.html
4. <http://www.mnre.gov.in/schemes/grid-connected/biomass-powercogen/>
5. <http://www.epa.gov/climatestudents/>
6. <http://www.climatecentral.org>
7. <http://www.envis.nic.in/>
8. <https://www.overshootday.org/>
9. <http://www.footprintcalculator.org/>
10. <https://www.carbonfootprint.com/calculator.aspx>

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

(c) Others:

- 1) www.nptel.iitm.ac.in
- 2) www.khanacademy

- A) **Course Code** : 2400408(T2400408)
 B) **Course Title** : Employability Skills Development (Common for all Programmes)
 C) **Pre- requisite Course(s)** :
 D) **Rationale** :

Education may only be enough to qualify for a job, but employability skills are the major criteria to be considered for a job role. Employability skills are building blocks of any career and they equip one to carry out roles in the company to the best of their ability. Employers usually check these employability skills before hiring. These sets of job-readiness skills are behaviors that are necessary for every job and are essential attitudes that enable students to grow in their careers. Employers value employability skills because they regard these as indications of how their employees will get along with other team members and customers, and how efficiently they will be able to handle the job performance and career success. Employers like to hire a technical expert who also displays well-rounded employability skills.

- 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** Build resume and showcase portfolio for placement activity.
CO-2 Face interviews and participate effectively in Group Discussions.
CO-3 Apply engineering tools in work situations and societal processes.

- 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	-	-	2		
CO-2	3	-	-	-	2	2	3		
CO-3	3	-	-	3	3	2	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				
2400408	Employability Skills Development	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)

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)	
2400408	Employability Skills Development	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.

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: T2400408

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Perform SWOT analysis and reflect.</p> <p><i>TSO 1b.</i> Develop skills in carrier planning & goal setting</p> <p><i>TSO 1c.</i> Build a Resume using Internet formats.</p> <p><i>TSO 1d.</i> Develop and Design portfolios.</p> <p><i>TSO 1e.</i> Maintain good grooming attire.</p> <p><i>TSO 1f.</i> Introduce oneself to others.</p> <p><i>TSO 1g.</i> Develop a personal website.</p>	<p>Unit-1.0 Goal Setting</p> <p>1.1 Career planning, SWOT</p> <p>1.2 Resume using Internet formats.</p> <p>1.3 Showcase portfolios.</p> <p>1.4 Personal grooming.</p> <p>1.5 Self-Introduction.</p> <p>1.6 Website Development.</p>	CO1
<p><i>TSO 2a.</i> Face interviews and E- Interviews confidently</p> <p><i>TSO 2b.</i> Participate in group discussions.</p> <p><i>TSO 2c.</i> Use Social media for personal enrichment & Netiquette</p> <p><i>TSO 2d.</i> Manage self for higher growth.</p> <p><i>TSO 2e.</i> Use body language for effective communication</p> <p><i>TSO 2f.</i> Manage Emotions for personal growth</p>	<p>Unit-2.0 Capacity Development</p> <p>2.1 Interview Skills</p> <p>2.2 Group Discussion – Do's & don'ts, leadership, Teamwork, how to interrupt, synthesis, and analysis of topics.</p> <p>2.3 Social Media for Personal Enrichment</p> <p>2.4 Body language</p> <p>2.5 Self-Management.</p> <p>2.6 Emotional Intelligence</p>	CO2
<p><i>TSO 3a</i> Develop & Maintain Social Contacts.</p> <p><i>TSO 3b</i> Engage in Social Service projects.</p> <p><i>TSO-3c</i> Collaborate for mutual advantage.</p> <p><i>TSO 3d</i> Apply QC-Tools in work situations.</p> <p><i>TSO 3e</i> Practice Lean Manufacturing Techniques for Production and Operations</p>	<p>Unit-3.0 Utilizing Potential</p> <p>3.1 Social Networking</p> <p>3.2 Social Engagements, Volunteering</p> <p>3.3 Collaboration & Team-work.</p> <p>3.4 QC-Tools – Check sheets, Fishbone Diagram, Histogram, Pareto chart, Control-chart, Scatter Diagram, Stratification,</p> <p>3.5 Lean Manufacturing, Kanban, Kaizen, Five S, Poka-yoke, Quality Circle</p>	CO3

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: Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments:

- 1 Build a resume for Placement Activity.
- 2 Prepare letters for job applications.

b. Micro Projects:

1. Prepare collage for personal grooming.
2. Develop a showcase portfolio.
3. Prepare a collage of different gestures and postures of Body Language.
4. Apply Five-S in a work situation.
5. Arrange Mock Interviews, appear, and video record. Reflect on your performance.
6. Organize Group discussions on current topics and video record. Reflect on your performance

c. Other Activities:

1. Seminar Topics:
 - Emotional Intelligence.
 - 21st Century Skills.
 - Multitasking
2. Visits: Visit nearby Job Fairs, Career Guidance Fairs, etc.
3. Self-Learning Topics:
 - Use of social media.
 - Self-introduction.
 - Self-grooming.
 - QC Tools.
 - Lean Manufacturing,
 - Emotional Intelligence.

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	30%	-	-	-	-	-	-
CO-2	40%	-	-	-	-	-	-
CO-3	30%	-	-	-	-	-	-
Total Marks	25	-	-	-	-	-	-

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): (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
1.	Group Discussion Tables and chairs	Round Table with seating arrangement for 15 person
2..	Mock Interviews infrastructure	2 parallel mock interview set up with recording facility.
3.	Ear phones	Compatible with mobile phones
4	Headphones	Compatible with laptop/desk top
5	Blue tooth	Compatible with mobile phones.
7.	CC TV Camera	Compatible to record presentations and addresses.
8.	Podium	For presentations on stage.
9.	Public address system	For public meetings.
10.	Full Glass Mirrors	For monitoring Body Language

R) Suggested Learning Resources:**(a) Books:**

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Employability Skills Skills for Employability	Dr. M. Sen Gupta	Innovation Publication Pvt Ltd, 2020 ISBN: 978-81-933819-1-5
2.	Employability Skills	Dr. Nishith Rajaram Dubey, Anupam Singh	Indra Publishing House, 2023 ISBN - 978-93-93577-68-9
3.	Organizational Behavior	A. K. Chitale, Rajendra Prasad Mohanty and Dr Nishith Dubey	PHI Learning Pvt Ltd ISBN 978-81-203-4696-3
4.	Managerial Skills	Dr Nishith Dubey & Prof Gitanjali Shrivastava	Shiva Prakashan, Indore, India,2010, ISBN 81-7677-100-7,
5.	Body Language	Allan Pease	Pease International PTY. Ltd Australia
6.	Production and Operations Management Goods & Services approach	Dr S.V Deshmukh, Dr A. K. Chitale and Dr Nishith Dubey	Archers & Elevators publishing house, Bangalore, ISBN 9789386501197
7.	Emotional Intelligence	Daniel Goleman	Word Press.Com, 9789382563792
8.	How to win friends and influence people	Dale Carnegie	Srishti Publishers & Distributors, Delhi, India

(b) Online Educational Resources:**1. 4-Year Plan For Career Success:**

https://eng.umd.edu/sites/clark.umd.edu/files/4%20Year%20Plan%20For%20Career%20Success_Categorized_1.pdf

2. CAREER DEVELOPMENT GUIDE https://www.engineersaustralia.org.au/sites/default/files/content-files/2016-12/career_development_guide_may_2014.pdf

3. Tips for successful career planning [tips://www.aryacollege.in/tips-for-successful-career-planning-in-2021/](https://www.aryacollege.in/tips-for-successful-career-planning-in-2021/)

4. Career Planning – Complete Guide<https://www.mygreatlearning.com/blog/what-is-career-planning/>

5. Build Resume: <https://www.themuse.com/advice/how-to-make-a-resume-examples>

6. Build Resume <https://resumegenius.com/blog/resume-help/how-to-write-a-resume>

7. Body Language: <https://ubiquity.acm.org/article.cfm?id=3447263>

8. Group Discussions: <https://brightspeaking.com/en/how-to-effectively-participate-in-a-group-discussion/>

9. Career planning & goal setting: <https://www.hays.com.au/career-advice/career-development/setting-career-goals>

10. Career planning & goal setting: <https://www.thebalancemoney.com/step-by-step-guide-to-setting-career-goals-2059883>

11. Collaboration & teamwork: <https://www.indeed.com/career-advice/career-development/teamwork-and-collaboration>

12. Interview skills: <https://www.youtube.com/watch?v=IKCTS9dY4h4>

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

(c) Others: -

- A) **Course Code** : **2400009(T2400009)**
 B) **Course Title** : Open Educational Resources (OER)
 C) **Pre- requisite Course(s)** :
 D) **Rationale** :

Open educational resources (OER) are openly-licensed, freely available educational materials that can be modified and redistributed by users. Learning about Open Educational Resources (OER), copyright, and Creative Commons licenses is a valuable endeavor for content creators, users, and anyone interested in sharing knowledge and creative works. Creative Commons licenses, offer a standardized way to grant permissions for the use and sharing of creative works. Learning about OER, copyright, and Creative Commons licenses is an ongoing process. As these fields evolve, it's important to stay informed and continue exploring new resources and practices.

After going through this course, students will at first place have reasonable idea to explore and use various OERs useful for their course of study and secondly, be motivated for fair use of resources available to them on various platform by understanding the restrictions and legal issues related to copyright and other licensing policies.

- 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** Use Open Educational Resources (OER) after their evaluation
CO-2 Use copyright material appropriately.
CO-3 Implement suitable Creative Common License.

- 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	-	2	-	-	3	-	3		
CO-2	-	2	-	-	3	-	3		
CO-3	-	3	-	-	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	Scheme of Study (Hours/Week)				
		Classroom Instruction (CI)		Notional Hours (TW/ Activities+ SL)	Total Hours (CI+TW/ Activities)	Total Credits (C)
		L	T			
2400009	Open Educational Resources	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)

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)	
2400009	Open Educational Resources	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.

H) 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.

I) Theory Session Outcomes (TSOs) and Units: T2400009

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain the difference between OER and other free educational materials.</p> <p><i>TSO 1b.</i> Describe the challenges and benefits of using OER in a class.</p> <p><i>TSO 1c.</i> Apply various aspects of evaluating OER before use</p> <p><i>TSO 1d.</i> Explain necessity to assess an OER's adaptability.</p> <p><i>TSO 1e.</i> Use preliminary search for open educational resource.</p> <p><i>TSO 1f.</i> Find OER using various resources.</p>	<p>Unit-1.0 Open Educational Resources</p> <p>1.1 OER - definition</p> <p>1.2 What is NOT OER.</p> <p>1.3 Benefits of using OER – Benefits to Students - Access to Quality Education</p> <p>1.4 OER - Benefits to Faculty - Use, Improve and Share, Network and collaborate with peers, Lower Cost, Improve access to information</p> <p>1.5 Challenges of Using OER – Subject Availability, Format and Material type availability, Time and Support availability</p> <p>1.6 Evaluating OER – a) Clarity, Comprehensibility, and Readability, b) Content and Technical Accuracy, c) Adaptability and Modularity, d) Appropriateness and Fit, e) Accessibility</p> <p>1.7 Finding Open Content - OER Search Scenario Filter by Usage Rights in Google, Repositories and Search Tools, Subject-specific Repositories</p>	CO1
<p><i>TSO 2a.</i> Explain benefits of copyright protection for creator</p> <p><i>TSO 2b.</i> Explain exceptions and limitations to copyright law</p> <p><i>TSO 2c.</i> List rights granted to copyright holders.</p> <p><i>TSO 2d.</i> Explain Exceptions and limitations to copyright law</p> <p><i>TSO 2e.</i> Explain Fair use/fair dealing apply to copyright</p> <p><i>TSO 2f.</i> Elaborate Public domain and how does it relate to copyright</p> <p><i>TSO 2g.</i> Elaborate penalties for copyright infringement.</p> <p><i>TSO 2h.</i> Explain copyright for digital content and the internet.</p> <p><i>TSO 2i.</i> Explain use of copyrighted works in education</p>	<p>Unit-2.0 Copyright and Open Licensing</p> <p>2.1 Copyright and what it does protect, benefits of copyright protection for creators, duration of copyright protection last, rights granted to copyright holders.</p> <p>2.2 Exceptions and limitations to copyright law, fair use/fair dealing apply to copyright</p> <p>2.3 Public domain and its relation to copyright.</p> <p>2.4 Penalties for copyright infringement</p> <p>2.5 Apply copyright to digital content and the internet</p> <p>2.6 Use of copyrighted works in education.</p> <p>2.7 Open Licenses – GNU – Free Documentation license, Free Art License</p> <p>2.8 Why Free Licenses – Retain, Reuse, Revise, Remix, Redistribute</p>	CO2

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<i>TSO 2j.</i> Explain the use of free licenses		
<i>TSO 3a.</i> Describe the four different Creative Commons License components. <i>TSO 3b.</i> Explain the reason some CC-licensed content might not be considered OER. <i>TSO 3c.</i> Explain the Strength and weakness of four Open CC Licenses <i>TSO 3d.</i> Choose the right Creative Commons license for work. <i>TSO 3e.</i> Apply a Creative Commons license to existing work. <i>TSO 3f.</i> Use of Creative Commons licenses for commercial purposes. <i>TSO 3g.</i> Modify a work licensed under Creative Commons. <i>TSO 3h.</i> Revoke a Creative Commons license, combine works with different Creative Commons licenses <i>TSO 3i.</i> Differentiate between Attribution and Citation	Unit-3.0 Creative Common Licenses 3.1 Alternatives to copyright as Creative Commons licenses. 3.2 Four components of creative common Licenses – Attribution, Share- Alike, Non – commercial, No Derivatives 3.3 Choosing a Creative common licenses – Wiley’s 5 Rs and Creative Common Licenses 3.4 Four Open CC Licenses and Their Strengths and Weaknesses – (a) CC BY (b) CC BY SA (c) CC BY NC (d) CC BY NC SA 3.5 Attribution Vs Citation - Creative Commons licensed work without giving attribution 3.6 Apply a CC License - choose the right Creative Commons license for work, apply a Creative Commons license to existing work, Creative Commons licenses be used for commercial purposes, modify a work licensed under Creative Commons, revoke a Creative Commons license, combine works with different Creative Commons licenses	CO3

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

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

a. Assignments:

Related to Open Educational Resources – CO1

- i. OER help to reduce the cost of education for students. Justify?
- ii. Explain why it is necessary to assess an OER’s adaptability?
- iii. Identify four search tools for finding open educational resources?
- iv. Identify at least two search tools for finding openly licensed media?

Related to Copyright – CO2

- i. Explain copyright and what does it protect
- ii. Explain the rights granted to copyright holders
- iii. Describe the exceptions and limitations to copyright law
- iv. Elaborate the way fair use/fair dealing apply to copyright?
- v. Describe the public domain and its relationship with copyright
- vi. Elaborate the penalties for copyright infringement?
- vii. Explain copyright apply to digital content and the internet
- viii. Explain the way copyright law address the use of copyrighted works in education

Related to Creative Common Licenses – CO3

- i. Explain various Creative Commons licenses
- ii. Describe, how can you apply a Creative Commons license to your existing work?
- iii. Explain the benefits of using Creative Commons licenses?
- iv. Elaborate, how you can modify a work licensed under Creative Commons?
- v. Are Creative Commons licenses valid worldwide?
- vi. Elaborate how Creative Commons license can be revoked, once it has been applied to your work?
- vii. Explain, how anyone use a Creative Commons licensed work without giving attribution?
- viii. Explain the limitations/restrictions while using works with Creative Commons licenses?

b. Micro Projects:

1. Collect information on the impact of OER on cost savings and student engagement.
2. Search at least four OER related to topic of your Engineering Discipline over Internet. Evaluate the material based on the relevance, accuracy and usability.
3. Explore the different types of resources under creative Commons licenses (e.g., CC BY, CC BY-SA, CC BY-NC, etc.) and their specific permissions and restrictions.
4. Create a comparative analysis chart or infographic that visually represents the key characteristics of each license.
5. Select minimum 5 real-world examples from different domains (such as music, art, literature, or education) where creators have used Creative Commons licenses.

c. Other Activities:

1. Seminar Topics:
 - OER Quality Assurance
 - OER Repositories and Platforms
 - Creative Commons and Digital Media
 - Creative Commons in the Visual Arts
 - Examine the legal implications of using Creative Commons licenses, including the obligations and responsibilities of both creators and users and present it.
2. Self-Learning Topics:
 - Open Licensing and Copyright: Understanding the Legal Framework for OER
 - Creative Commons and the future of Copyright
 - Copyright and Open Access Publishing
 - Copyright and Software

K) 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, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, 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.

L) List of Major Laboratory Equipment, Tools and Software: (If Any)

S. No.	Name of Equipment, Tools and Software	Broad Specifications
1.	Computers	Desktop computer with word processing and presentation facility
2.	Internet	Internet Connectivity

M) Suggested Learning Resources:**(a) Books:**

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	The OER Starter Kit.	Abbey Elder - 2019	IA: Iowa State University Digital Press, available under a Creative Commons Attribution 4.0 International License. Retrieved from iastate.pressbooks.pub/oyerstarterkit
2.	A Brief History of Open Educational Resources	Bliss, T J and Smith, M. - 2017	In: Jhangiani, R S and Biswas-Diener, R. (Eds.) Open: The Philosophy and Practices that are Revolutionizing Education and Science (pp. 9–27). London: Ubiquity Press. DOI: https://doi.org/10.5334/bbc.b .

Note: Above listed books are available in soft form and can be downloaded as given respective link

(b) Online Educational Resources:

- OER for Empowering Teachers Instructional Material by P. Malliga is licensed under a Creative Commons Attribution 4.0 International License.
- William & Flore Hewlett Foundation. (n.d.). OER defined. Retrieved from <https://hewlett.org/strategy/open-educational-resources/>
- Free Software Foundation. (2008). GNU Free Documentation License. Retrieved from <https://www.gnu.org/licenses/fdl.html>
- Copyleft Attitude. (2007). Free Art License 1.3. Retrieved from <http://artlibre.org/licence/lal/en/>
- Free Software Foundation. (n.d.). What is copyleft? Retrieved from <https://www.gnu.org/copyleft/copyleft.html>

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