

Curriculum of Diploma Programme
in
Chemical Engineering



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

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

Semester – III Teaching & Learning Scheme

Course Codes	Category of course	CourseTitles	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				
2414301	PCC	Introduction to Chemical Engg.	02	01	-	02	05	04
2414302	PCC	Technology of Inorganic Chemicals	02	01	-	02	05	04
2414303	PCC	Industrial Stoichiometry	02	01	-	02	05	04
2414304	PCC	Mechanical Operation	03	-	04	02	09	06
2418305	BCC	Python Programming (CE, CSE, AIML, EE, ME, ME (Auto.), ELX, ELX (R), MIE, FTS, CRE, CHE, TE, CACDDM, GT)	03	-	04	02	09	06
2400006	NRC	Environmental Education and Sustainable Development (Common for All Programmes)	01	-	01	01	03	02
2414306	PSI	Summer Internship – I (After 2 nd Sem) (Common for all programmes)	-	-	02	02	04	02
2400007	NRC	Indian Constitution (Common for All Programmes)	01	-	-	-	01	01
2400107	NRC	Professional Ethics (CE, CSE, ELX, ELX (R), FTS, ME, AIML, MIE, CHE, CRE, FPP, GT, EE, AE, CACDDM)	01	-	-	-	01	01
Total			15	3	11	13	42	30

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

Legend:

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

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

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

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

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

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

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

Semester - III Assessment Scheme

Course Codes	Category of course	Course Titles	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2414301	PCC	Introduction to Chemical Engg.	30	70	20	30	-	-	150
2414302	PCC	Technology of Inorganic Chemicals	30	70	20	30	-	-	150
2414303	PCC	Industrial Stoichiometry	30	70	20	30	-	-	150
2414304	PCC	Mechanical Operation	30	70	20	30	20	30	200
2418305	BCC	Python Programming (CE, CSE, AIML, EE, ME, ME (Auto)., ELX, ELX (R), MIE, FTS, CRE, CHE, TE, CACDDM, GT)	30	70	20	30	20	30	200
2400006	NRC	Environmental Education and Sustainable Development (Common for All Programmes)	15	-	10	-	10	15	50
2414306	PSI	Summer Internship – I (After 2 nd Sem) (Common for all programmes)	-	-	10	15	10	15	50
2400007	NRC	Indian Constitution (Common for All Programmes)	25	-	-	-	-	-	25
2400107	NRC	Professional Ethics	25	-	-	-	-	-	25
Total			215	350	120	165	60	90	1000

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

Legend:

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

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

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

Note:

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

- A) **Course Code** : 2414301(T2414301/S2414301)
 B) **Course Title** : Introduction to Chemical Engineering
 C) **Pre- requisite Course(s)** :
 D) **Rationale** :

Diploma Chemical engineers work as first line managers in chemical process industries. Chemical engineers have to perform various routine activities like operation, process maintenance of various chemical equipments etc. Hence knowledge of unit operations, unit processes, basic concepts like design and drawing, process flow chart, plant layout, physical and chemical properties of basic raw materials and products are necessary. This course is designed to equip the students with necessary knowledge and skills required for effective performance in the different job roles related to chemical engineering.

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

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

- CO-1** Illustrate Indian knowledge system related to chemical engineering.
CO-2 Apply the concept of different components viz. mathematics, physics, chemistry etc. to solve the chemical engineering problems.
CO-3 Solve chemical engineering problems using concepts of unit operations and processes.
CO-4 Analyze the deciding factor for plant set up (location).
CO-5 Choose appropriate job opportunity and their future in chemical engineering.

- 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	-	-	2	-	-		
CO-2	2	2	2	-	-	-	1		
CO-3	2	2	2	2	-	-	1		
CO-4	3	-	-	1	2	2	-		
CO-5	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				
2414301	Introduction to Chemical 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)	
2414301	Introduction to Chemical 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.

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: T2414301

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Identify the role of chemical engineer in the society.</p> <p><i>TSO 1b.</i> Explain the greatest achievement of chemical engineering.</p>	<p>Unit-1.0 History and Achievement of Chemical Engineering in context with Indian Knowledge System.</p> <p>1.1 History of Chemical engineering. 1.2 Role of chemical engineering in society. 1.3 Personalities of chemical engineering. 1.4 Greatest achievement of chemical engineering.</p>	CO-1
<p><i>TSO 2a.</i> Apply the concept of mathematics, physics, and chemistry to solve the chemical engineering problems.</p> <p><i>TSO 2b.</i> Identify the different components of chemical engineering.</p>	<p>Unit-2.0 Components of Chemical Engineering</p> <p>2.1 Science as a component of chemical engineering: role of mathematics, role of physics, role of chemistry. 2.2 Computer as a component of chemical engineering: MATLAB, aspen++, virtual lab. 2.3 Role of thermodynamics, fluid flow operation, chemical kinetics as a component of chemical engineering. 2.4 Role of electronics controller as a component of chemical engineering: process dynamics, design, and control.</p>	CO-2
<p><i>TSO 3a.</i> Apply basic concept of unit operation & unit process in chemical industries.</p> <p><i>TSO 3b.</i> Differentiate unit operations and unit processes.</p> <p><i>TSO 3c.</i> Use standard symbols for identification of different equipment's and instruments in chemical engineering plant.</p>	<p>Unit-3.0 Unit Operations and Unit Processes</p> <p>3.1 Concept of unit operation and unit processes. 3.2 Major Unit Operations: Mechanical operations, Heat Transfer, Mass Transfer, Fluid mechanics. 3.3 Major Unit Processes: Technology of inorganic and organic chemicals. 3.4 Chemical and instrumentation symbols: flowsheet representation of process plant.</p>	CO-3
<p><i>TSO 4a.</i> Identify the different operating unit processes and fix their locations in the plant.</p> <p><i>TSO 4b.</i> Identify and place equipment's and machinery in specific area.</p> <p><i>TSO 4c.</i> Use the utilities in the chemical manufacturing processes safely.</p>	<p>Unit-4.0 Chemical Plant Location and Plant Layout</p> <p>4.1 Ideal Plant Location. 4.2 Factors deciding plant location. 4.3 Plant Layout: Components of plant layout. 4.4 Process and Process flow diagram (PFD). 4.5 Process and utility- pipeline color coding, 4.6 Insulation - Types and applications.</p>	CO-4
<p><i>TSO 5a.</i> Identify new technological advancement range of scale in chemical engineering.</p> <p><i>TSO 5b.</i> Choose appropriate job opportunity in chemical engineering discipline.</p> <p><i>TSO 5c.</i> Plan their future in chemical engineering field.</p>	<p>Unit-5.0 Future and Opportunities for Chemical Engineering.</p> <p>5.1 Paradigm shifts in chemical engineering. 5.2 Job opportunities for chemical engineering. 5.3 Job profile for chemical engineering. 5.4 Future of chemical engineering.</p>	CO-5

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

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

- L) Suggested Term Work and Self Learning: S2414301** 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
- Compare unit operation and unit process.
 - Distinguishing features of chemical engineering with other engineering streams.
 - Prepare a report regarding history and achievements of chemical engineering.
 - Enlist the job opportunities for diploma in chemical engineering in India.
- b. Micro Projects:**
- Visit nearby chemical plant and identify and list the different unit operations and unit processes.
 - Visit nearby chemical plant and identify the role of production Engineer & their future in the industry. Make a detail report on it.
 - Make a pilot plant for industrial waste water treatment plant.
 - Prepare a report on the role of unit operation equipment for the industrial waste water treatment plant.
- c. Other Activities:**
- Seminar Topics:
 - Equipments used in unit operations with their symbols
 - Comparison of production capacity of different fertilizer plant situated in Bihar & Jharkhand.
 - Visits: Visit a nearby Fertilizer plant and prepare a brief report on different unit operation equipment used in plant.
 - Self-Learning Topics:
 - Laplace transform & its application.
 - Importance of dimensionless number in chemical engineering field.
 - Correlation between heat transfer and mass transfer.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
Assignments			Micro Projects	Other Activities*			
CO-1	10%	10%	10%	05%	05%	-	-
CO-2	20%	20%	20%	25%	30%	-	-
CO-3	30%	30%	30%	25%	30%	-	-
CO-4	30%	30%	30%	30%	30%	-	-
CO-5	10%	10%	10%	15%	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 History and Achievement of Chemical Engineering	7	CO-1	07	4	3	-
Unit-2.0 Components of Chemical Engineering	10	CO-2	14	5	5	4
Unit-3.0 Unit Operations and Processes	12	CO-3	21	4	9	8
Unit-4.0 Chemical Plant Location and Plant Layout	12	CO-4	21	4	8	9
Unit-5.0 Future and Opportunities for Chemical Engineering	7	CO-5	07	3	2	2
Total	48	-	70	20	27	23

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.	Chemical Engineering vol-6	Coulson and Richardson	CBS, Latest Edition
2.	Plant Design and Economics for Chemical Engineering.	Peter Timmorhaus	McGraw-Hill Education, Latest Edition
3.	Industrial Safety Management	Tarafdar & Tarafdar	Jain Book depot, Latest Edition
4.	Introduction of Chemical Engineering	S. Ghosal, S. Sanyal, S. Dutta	Tata McGraw-Hill, Latest Edition

(b) Online Educational Resources:

- https://en.wikipedia.org/wiki/Unit_operation.
- www.cbspd.com/website/unit-operations-and-unit-processes-vol-2.htm
- <https://cheme.stanford.edu/academics-admissions/where-do-chemical-engineers-work/introduction-chemical-engineering-lectures>
- <https://www.msubbu.in/In/pce/index.html>

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:

- NPTEL
- MIT Open course lecture available on Internet etc.

- A) **Course Code** : 2414302(T2414302/S2414302)
 B) **Course Title** : Technology of Inorganic Chemicals
 C) **Pre- requisite Course(s)** :
 D) **Rationale** :

This subject is related to the chemical industry to impart the basic concepts of chemical technology. The basic principles to develop unit processes and unit operations in various industries are comprehended through this course. The manufacturing processes of inorganic chemicals and its applications are mentioned in this course curriculum. A diploma engineers must learn the process flow sheet or diagram for the manufacturing inorganic chemical.

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

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

- CO-1** Illustrate the properties & manufacturing processes and applications of different inorganic acids.
CO-2 Use relevant industrial gases for manufacture of specific fertilizer.
CO-3 Select the appropriate fertilizer for specific agriculture soil.
CO-4 Enumerate the properties & manufacturing process of different chlor alkali.
CO-5 Recommend the types of cement for a particular duty/application.

- 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	-	-	-		
CO-2	2	-	-	-	-	1	1		
CO-3	2	2	1	-	2	-	1		
CO-4	2	2	-	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)
		L	T				
2414302	Technology of Inorganic Chemicals	02	01	-	02	05	04

Legend:

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H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
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		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2414302	Technology of Inorganic Chemicals	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)

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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: T2414302

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Draw the flow sheet with description for the manufacturing of minerals acid in industries.</p> <p><i>TSO 1b.</i> Explain the physical and chemical properties of mentioned inorganic acids.</p> <p><i>TSO 1c.</i> List the uses, applications and economics involved in the minerals acid industries.</p> <p><i>TSO 1d.</i> Identify the major engineering problems associated with manufacturing of nitric acids.</p>	<p>Unit-1.0 Inorganic Acid Industries</p> <p>1.1 Hydrochloric acid: physical and chemical properties, Manufacturing process, flow diagram, industrial uses and applications, major engineering problems & economics of process.</p> <p>1.2 Sulfur and sulfuric acid: Raw materials, chemical reaction and physical properties, manufacturing process, process flow diagram, industrial applications and uses, economics of process</p> <p>1.3 Nitric acid: physical and chemical properties, manufacturing process, flow diagram, industrial applications and uses, major engineering problems & economics of process during manufacturing.</p> <p>1.4 Phosphoric acids: Phosphorus & Phosphoric Acid Raw materials, chemical reaction, physical properties, manufacturing process, process flow diagram, industrial applications, uses and economics of process</p>	CO1
<p><i>TSO 2a.</i> Explain the general properties of industrial gases.</p> <p><i>TSO 2b.</i> Describe the manufacturing process & application of different industrial gases.</p> <p><i>TSO 2c.</i> Identify the major engineering problems involved in the manufacturing process of industrial gases.</p>	<p>Unit-2.0 Industrial Gases.</p> <p>2.1 Definition, physical & chemical properties of Industrial gases.</p> <p>2.2 Manufacturing process of Industrial Gases viz. Oxygen, Nitrogen, Hydrogen, Water Gas, Producer Gas, Carbon di oxide, Acetylene.</p> <p>2.3 Application of Industrial gases.</p> <p>2.4 Major engineering problems & economics of process during manufacturing of industrial gas.</p>	CO1
<p><i>TSO 3a</i> Explain the manufacturing process of various primary fertilizer (Nitrogen).</p> <p><i>TSO 3b</i> Describe the importance of ammonia for the manufacturing of urea, ammonium sulfate and ammonium nitrate.</p> <p><i>TSO 3c</i> Compare single superphosphate and triple superphosphate.</p> <p><i>TSO 3d</i> List the uses & economics of NPK & mixed fertilizer.</p>	<p>Unit-3.0 Fertilizer Industry.</p> <p>3.1 Nitrogen fertilizers: Ammonia: Raw materials, chemical reaction, physical properties, manufacturing process, process flow diagram, industrial applications, uses and economics of process</p> <p>3.2 Urea: Raw materials, chemical reaction, physical properties, manufacturing process, process flow diagram, industrial applications, uses and economics of process.</p> <p>3.3 Ammonium sulphate: Raw materials, chemical reaction, physical properties, manufacturing process, process flow diagram, industrial applications, uses and economics of process.</p> <p>3.4 Ammonium nitrate: Raw materials, chemical reaction, physical properties, manufacturing</p>	CO2

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	process, process flow diagram, industrial applications, uses and economics of process. 3.5 Phosphorus fertilizers: Single super phosphate and triple super phosphate: Raw materials, chemical reaction, physical properties, manufacturing process, process flow diagram, industrial applications, uses and economics of process. 3.6 Mixed fertilizer: NPK fertilizer: Raw materials, chemical reaction, physical properties, manufacturing process, process flow diagram, industrial applications, uses and economics of process	
<i>TSO 4a</i> List the uses of caustic soda & their composition in chemical process. <i>TSO 4b</i> Explain the manufacturing process & industrial application of bleaching powder. <i>TSO 4c</i> Identify major engineering problems involved in the chlor alkali.	Unit-4.0 Chlor Alkali Industries. 4.1 Soda ash (sodium carbonate): method of production, physical and chemical properties, process flow diagram, industrial applications, uses and economics of process. 4.2 Caustic soda: physical and chemical properties, method of production, process flow diagram, industrial application, uses and economics of process. 4.3 Bleaching powder: introduction, chemical and physical properties, process flow diagram, industrial applications, uses, economics of process.	CO4
<i>TSO 5a</i> Explain the raw materials, manufacturing process & uses of different types of cements. <i>TSO 5b</i> Recommend the Use of Portland & pozzolana cement. <i>TSO 5c</i> Identify the major engineering problems involved in the cement industries.	Unit-5.0 Cement Industries. 5.1 Types of cement, raw materials, industrial applications & their uses. 5.2 Manufacturing of Portland cement. 5.3 Manufacturing of pozzolana cement. 5.4 Major engineering problems & economics of process	CO5

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: S2414302 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 such as:

- Prepare dilute sulfuric acid of given normality from concentrated sulfuric acid of given normality.
- Survey the literature and describe industry wise consumption pattern of soda ash & caustic soda in different regions of the city.
- Make report on urea manufacturing units in India with its production capacity along with technologies being adopted.
- Survey at least 25 nearby village / cooperative stores and ascertain the consumption pattern of fertilizers used in the industry of district.

b. Micro Projects:

- Prepare chlorine from bleaching powder in the lab.
- Prepare Nitric acid in lab with the help of potassium nitrate and sulfuric acid. (This project require extreme level of care as corrosive materials are used; it should be performed under the supervision of class teacher). Prepare a report and submit in the department.
- Synthesize phosphorous trichloride in laboratory with the help of White phosphorous and chlorine gas. Prepare a report.
- Prepare water gas in the laboratory.
- Prepare soda ash in the laboratory with the help of salt and lime stone.
- Prepare hydrochloric acid in the laboratory with the help of common salt and sulfuric acid.

c. Other Activities:

1. Seminar Topics:

- Negative effect of chlor alkali industries on the environment.
- Role of various unit operation equipment used in chemical production industries.

2. Visits: Visit nearby chemical industry with utilities. Prepare report of visit with special comments of chemical industry technique used, material used, single component/batch production/mass production and cost of chemical processes.

3. Self-Learning Topics:

- Economics of inorganic acid industries.
- Application of industrial gases.
- Uses of mix fertilizer in agriculture.
- Compare between soda ash and caustic soda.
- Application of Portland cement.

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	20%	20%	10%	10%	10%	-	-
CO-2	30%	30%	30%	25%	25%	-	-
CO-3	30%	30%	30%	25%	25%	-	-
CO-4	10%	10%	15%	15%	20%	-	-
CO-5	10%	10%	15%	25%	20%	-	-
Total Marks	30	70	20	20	10	-	-
			50				

Legend:

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

**.: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Inorganic Acid Industries	8	CO 1	14	2	8	4
Unit-2. Chloral Alkali Industry	8	CO 2	21	6	8	7
Unit-3.0 Fertilizer Industry	8	CO 3	21	7	8	6
Unit-4.0 Industrial Gases	12	CO 4	7	3	2	2
Unit-5.0 Cement Industries.	12	CO 5	7	2	3	2
Total	48	-	70	20	29	21

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	Publisher and Edition with ISBN
1	Outlines of Chemical Technology by Dryden	M.Gopal Rao & Marshall sitting	East-West press Third & 2001
2	Chemical Process Technology, Vol-I	Shukla and Pandey	Vikash, 1977
3	Chemical Process Industries	Shreve	McGraw Hill, Fifth & 2012
4	Chemical Process Technology and Simulation	Srikumar Koyikkal	PHI learning, First & 2013
5	Hand book of Industrial Chemistry Vol-I	Davis K H	CBS Publisher, 2005
6	Testing Manual of Paints, Varnishes and Resins	H Panda	Asia Pacific Business, 2011 Press Inc. ISBN: 9788178331416

(b) **Online Educational Resources:**

1. Sulfuric acid - www.fch.vut.cz/~fiserova/down/krouskaprezentace.ppt
2. Soda ash - Soda ash - nptel.ac.in/courses/103106108/Lecture%209.pdf
3. Industrial gases - <https://nzic.org.nz/ChemProcesses/production/1K.pdf>
4. Ammonia - www.chemguide.co.uk/physical/equilibria/haber.html
5. Urea - <https://nzic.org.nz/ChemProcesses/production/1A.pdf>
6. Phosphoric acid - nptel.ac.in/courses/103106108/Lecture%2021.pdf

- A) **Course Code** : 2414303(T2414303/S2414303)
 B) **Course Title** : Industrial Stoichiometry
 C) **Pre- requisite Course(s)** : Applied Physics, Chemistry, and Mathematics
 D) **Rationale** :

The purpose of this course is to introduce chemical engineering students to the basic principles and calculation techniques used in the chemical industries and to acquaint them with the fundamentals of the material and energy balances as applied to chemical engineering processes. It will expose them to solve the problems in material and energy balances that arise in relation to the problems involving in different chemical process units. The unit conversions, material and energy balance are the essential part in the practice of other courses such as mechanical operations, fluid flow, heat Transfer, mass transfer etc. Thus, this course is a core course for diploma in chemical engineering and should be learned sincerely by students.

- 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** Convert units among different systems.
CO-2 Apply stoichiometric principles for solving chemical engineering problems.
CO-3 Calculate important quantities for ideal gas mixture.
CO-4 Calculate material balance for chemical process.
CO-5 Calculate energy balance for chemical process.

- 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	1	-	-	-	1		
CO-3	3	2	1	1	1	-	1		
CO-4	3	3	2	1	-	1	2		
CO-5	2	3	2	1	1	-	2		

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

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

- G) **Teaching & Learning Scheme:**

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2414303	Industrial Stoichiometry	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)	
2414303	Industrial stoichiometry	30	70	20	30	-	-	150

Legend:

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

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

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

Note:

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

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (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: T2414303

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain the importance of unit system for process calculation.</p> <p><i>TSO 1b.</i> Apply general guideline for the conversion of units.</p> <p><i>TSO 1c.</i> Use the fundamental units to find the derived quantity.</p> <p><i>TSO 1d.</i> Explain the importance of dimensionless group in chemical engineering.</p>	<p>Unit-1.0 Units and Measurements for Process Calculation.</p> <p>1.1 System of units: SI units, CGS units, fundamental units, and derived units.</p> <p>1.2 General guidelines on the use of SI units.</p> <p>1.3 Some important derived quantity and their conversion: force, volume, pressure, work, energy, power, heat.</p> <p>1.4 Dimensionless groups in chemical engineering: Reynold's no., specific gravity, Prandtl No., Nusselt No. etc.</p>	CO-1
<p><i>TSO 2a.</i> Calculate important physical quantities.</p> <p><i>TSO 2b.</i> Calculate the composition of solid, liquid, and gas for a given mixture.</p> <p><i>TSO 2c.</i> Calculate Molality, Normality, Morality, gm/lit and related simple numerical.</p>	<p>Unit-2.0 Fundamental concepts of Chemical Calculation.</p> <p>2.1 Definition and calculations of mole, atomic weight, molecular weight, equivalent weight, specific gravity, and API gravity.</p> <p>2.2 Calculation for composition of solids, liquids, and gaseous mixture.</p> <p>2.3 Molality, Normality, Morality, gm/lit and related simple numerical.</p>	CO-2
<p><i>TSO 3a.</i> Derive ideal gas law.</p> <p><i>TSO 3b.</i> State different laws of ideal gas.</p> <p><i>TSO 3c.</i> Establish relationship between mole%, volume%, and pressure% for ideal gases.</p> <p><i>TSO 3d.</i> Calculate important quantities for ideal gas mixture such as average molecular weight, density etc.</p>	<p>Unit-3.0 Ideal Gas Law</p> <p>3.1 Ideal gas law: concept, derivation, STP and NTP conditions.</p> <p>3.2 Statement and mathematical expression of Dalton's law, Amagat's law, Raoult's Law, and Henry's Law.</p> <p>3.3 Relation between mole%, volume% and pressure% of ideal gases.</p> <p>3.4 Calculation of importance quantities for ideal gas mixture: average molecular weight, density, mole%, weight% in SI/MKS systems.</p>	CO-3
<p><i>TSO 4a.</i> Explain law of conservation of mass.</p> <p><i>TSO 4b.</i> Apply component balance and overall balance for solving material balance problem.</p> <p><i>TSO 4c.</i> Explain the working principle of different chemical engineering equipment.</p> <p><i>TSO 4d.</i> Calculate mass balance on important unit operation equipment.</p> <p><i>TSO 4e.</i> Describe purging, recycling, and bypassing operations.</p> <p><i>TSO 4f.</i> Explain basic concepts of Limiting reactant, Excess reactant, yield, conversion & selectivity.</p> <p><i>TSO 4g.</i> Calculate mass balance with chemical reaction.</p>	<p>Unit-4.0 Material Balance Calculation on Chemical Engineering Equipment.</p> <p>4.1 Statement of Law of conversation of mass.</p> <p>4.2 Basic material balance principle: component balance and overall balance.</p> <p>4.3 Steps for solving material balance problems.</p> <p>4.4 Brief description and simple material balance calculation of Drying, Distillation, Absorption, Mixing, Crystallization, and Evaporation.</p> <p>4.5 Single stage material balance calculation of Leaching and Extraction.</p> <p>4.6 Brief idea regarding Recycling, Purging and Bypassing operation.</p> <p>4.7 Definition: Limiting reactant, Excess reactant, conversion, yield, and selectivity.</p>	CO-4

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	4.8 Simple numerical for finding yield, conversion, and composition. 4.9 Simple calculation of material Balance based on reaction.	
<p><i>TSO 5a.</i> Explain law of conversion of energy.</p> <p><i>TSO 5b.</i> Describe different forms of energy.</p> <p><i>TSO 5c.</i> Calculate heat capacity, specific heat, heat capacity of gas mixture.</p> <p><i>TSO 5d.</i> Calculate standard heat of formation and heat of reaction.</p> <p><i>TSO 5e.</i> Explain the effect of temperature on standard heat of reaction.</p> <p><i>TSO 5f.</i> Verify Hess's law with the help of simple problems.</p>	<p>Unit-5.0 Energy Balance Calculation on Chemical Engineering Equipment.</p> <p>5.1 Law of conservation of energy.</p> <p>5.2 Basic definitions and expressions for components of energy balance such as heat, work, kinetic energy, potential energy, and enthalpy.</p> <p>5.3 Definition of Heat capacity and specific heat, Mean heat capacity of mixtures of gases.</p> <p>5.4 Calculations of heat capacity by integral equation up to three terms.</p> <p>5.5 Definition and estimation of heat of fusion, heat of vaporization, and heat of sublimation.</p> <p>5.6 Concept and calculations of standard heat of formation, heat of combustion and heat of reaction in a chemical reaction.</p> <p>5.7 Effect of temperature on standard heat of reaction.</p> <p>5.8 Hess's Law and calculations.</p>	CO-5

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

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

L) **Suggested Term Work and Self Learning: S2414303** 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 Such as:
- Find out derived units for force, pressure, work, Internal energy, thermal conductivity, power, specific heat, density and viscosity.
 - Enumerate common chemical engineering dimensionless numbers.
 - List specific heat and heat capacity of some important materials.

b. **Micro Projects:**

- Visit of chemical process plant: Prepare block diagram showing material balance for process equipment used in plant which you have visited.
- Visit nearby plant to find bypass, recycle and purging operation with suitable description.
- Make a material balance of Steam distillation unit by performing simple experiment.
- Measure length/breadth/diameter/ mass of given objects and calculate their volume, density, and specific gravity.

c. **Other Activities:**

- Seminar Topics:
 - Composition of mixtures and mole concept with the help of video clip.
 - Thermal properties of matter.
- Visits: Visit a nearby Refinery plant and prepare a brief report on material balance and energy balance used at different unit operation equipment used in plant.

3. Self-Learning Topics:

- Calculate material balance for chemical process.
- Calculate energy balance for chemical process.
- Solve numerical problems on weight, volume, and mole percentage.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	10%	10%	10%	-	-
CO-2	20%	20%	20%	20%	10%	-	-
CO-3	30%	30%	30%	20%	20%	-	-
CO-4	30%	30%	30%	25%	30%	-	-
CO-5	10%	10%	10%	25%	30%	-	-
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 Units and Measurements for Process Calculation.	7	CO-1	07	3	4	-
Unit-2.0 Fundamental concept of Chemical Calculation.	10	CO-2	14	5	5	4
Unit-3.0 Ideal Gas Law	12	CO-3	21	8	7	6
Unit-4.0 Material Balance Calculation on Chemical Engineering Equipment.	12	CO-4	21	4	9	8
Unit-5.0 Energy Balance Calculation on Chemical Engineering Equipment.	7	CO-5	07	-	3	4
Total	48	-	70	20	28	22

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.

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.	Stoichiometry	B I Bhatt and S B Thakore	McGraw Hill Education; latest edition, ISBN: 9780070681149
2.	Basic Principles and Calculations in Chemical Engineering.	Himmelablaue David M.	PHI Learning, New Delhi, ISBN: 9789332549623
3.	Stoichiometry and Process Calculations	Narayanan K.V. and LakshmiKutty B	PHI; latest edition, ISBN: 8120352890
4.	Introduction to Process Calculations (Stoichiometry)	K. A. Gavhane	Nirali Prakasan, Pune, latest edition, ISBN: 9788190639668

(b) Online Educational Resources:

1. <https://nptel.ac.in/courses/103103165>
2. <https://archive.nptel.ac.in/courses/103/105/103105209/>
3. <https://www.unitoperation.com/>
4. <https://www.mooc-list.com/tags/stoichiometry>
5. <https://study.com/academy/topic/stoichiometry.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.

(c) Others:

1. NPTEL
2. MIT Open course lecture available on Internet etc.

- A) **Course Code** : 2414304(T2414304/P2414304/S2414304)
 B) **Course Title** : Mechanical Operation
 C) **Pre- requisite Course(s)** :
 D) **Rationale** :

The main objective of this subject is to understand properties and characterization of particulate solids and mechanical solids separation methods such as screening, filtration, sedimentation, transportation of solids, agitation etc. and associated equipment used for achieving these methods. Therefore, students must have information about the principles, construction, working and application of these equipments so that they can plan for their efficient use in plants. In this course the students would also learn simple calculations to judge the performance of these equipment.

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

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

- CO-1** Illustrate the characteristic, properties, classification, and storage of solids.
CO-2 Select the proper equipment for size reduction.
CO-3 Use the different separation techniques for separation of solids based on their specific properties.
CO-4 Apply the concept of filtration theory to estimate the filtration rate & cake resistance of filtration processes.
CO-5 Use the mixing and agitation process for understanding the flow pattern for agitated vessel.

- 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		
CO-2	2	2	2	2	1	1	-		
CO-3	1	2	2	2	2	2	1		
CO-4	1	3	3	2	2	2	1		
CO-5	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)					Total Credits (C)
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	
		L	T				
2414304	Mechanical Operation	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)	
2414304	Mechanical Operation	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: T2414304

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain specific properties of solids.</p> <p><i>TSO 1b.</i> Enumerate various characteristics of solid particles.</p> <p><i>TSO 1c.</i> Compare particulate solid and bulk solid.</p>	<p>Unit-1.0 Properties and Storage of Solids</p> <p>1.1 Characterization of solid particles.</p> <p>1.2 Particle shape and size.</p> <p>1.3 Average particle size.</p> <p>1.4 Storage of bulk solid.</p> <p>1.5 Flow of bulk solid.</p> <p>1.6 Problem associated with the flow of bulk solid.</p>	CO-1
<p><i>TSO 2a.</i> Identify suitable equipment for Grinding/Crushing.</p> <p><i>TSO 2b.</i> Compare crushing and grinding operation.</p> <p><i>TSO 2c.</i> Choose suitable screening equipment for solid-solid separation.</p> <p><i>TSO 2d.</i> Identify the factor affecting performance of screening operation.</p>	<p>Unit-2.0 Size Reduction and Separation of Solids</p> <p>2.1 Concept and importance of size reduction.</p> <p>2.2 Energy and power requirement for size reduction using different laws: Rittinger's law, Kick's law, Bond's law.</p> <p>2.3 Size-reduction equipment: types, principle and working of Jaw Crusher, Gyratory Crusher, Roll Crusher, Tumbling Mill, and Ball Mill, Fluid Energy Mill.</p> <p>2.4 Comparison of Crushing and Grinding operation.</p> <p>2.5 Open-Circuit and Closed-Circuit Grinding.</p> <p>2.6 Concept and importance of screening operation.</p> <p>2.7 Classification of Screens based on performance: Ideal Screen and Actual Screen.</p> <p>2.8 Factors affecting performance of screens.</p> <p>2.9 Types and working of screening equipment: Grizzly Screen, Trommel Screen, Gyratory Screen, Shaking and Vibrating Screen.</p> <p>2.10 Capacity and effectiveness of Screens based on under size and over size material for a Screen.</p> <p>2.11 Types of Screen analysis: Differential analysis and Cumulative analysis.</p>	CO-2, CO-3
<p><i>TSO 3a.</i> Identify separation equipment based on the specific properties of the particles.</p> <p><i>TSO 3b.</i> Choose the proper separation equipment based on electrical and magnetic properties of the particles.</p>	<p>Unit-3.0 Separation of Solids based on Specific Properties</p> <p>3.1 Separation of solid particles based on their terminal settling velocity: Gravity settling tank, Cone Classifier, Rake Classifier, Spiral Classifier.</p> <p>3.2 Separation of solid particles from liquid and gas: Cyclone Separator, Froth Floatation Cell.</p> <p>3.3 Separation of solid particles based on electrical and magnetic properties: Electrostatic Precipitator and Magnetic Drum Separator.</p> <p>3.4 Removal of fine particulate solid from a gas/air stream: Venturi Scrubber, Cyclone Separator.</p>	CO-3
<p><i>TSO 4a.</i> Distinguish between different types of Filtration process.</p> <p><i>TSO 4b.</i> Identify the factor affecting the rate of Filtration.</p>	<p>Unit-4.0 Filtration and Sedimentation</p> <p>4.1 Concept and Types of filtrations: based on (a) Cake resistance: Cake filtration and Deep Bed Filtration.</p>	CO-4

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<i>TSO 4c.</i> Compare between Sedimentation and Filtration process.	(b) Process: constant rate and constant pressure filtration. 4.2 Characteristics of filter medium. 4.3 Factors affecting the rate of filtration. 4.4 Types of filtration equipment: Rapid Sand Filter, Plate and Frame Filter Press, Vacuum Filter, Centrifugal Filter. 4.5 Concept and principle of Sedimentation. 4.6 Difference between Sedimentation and Filtration.	
<i>TSO 5a.</i> Explain homogeneous properties of material by using Agitation and Mixing process. <i>TSO 5b.</i> Calculate the power consumption of Impeller in Mixing and Agitation process.	Unit-5.0 Mixing and Agitation Process 5.1 Concept and importance of Mixing and Agitation, Factors affecting Mixing and Agitation process. 5.2 Principle, construction, working and application of Agitated Vessel. 5.3 Flow patterns in Agitated Vessel, Concept of Swirling and Vortex, Prevention of Swirling and Vortex formation in Agitated Vessel. 5.4 Calculation of Power consumption for Impeller in Agitated Vessel. 5.5 Principle, construction, working and application of Mixer. 5.6 Types of mixers: Ribbon Blender, Double-Arm Kneaders, Banbury Mixer, Muller Mixer.	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: P2414304

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 1.1.</i> Separate various raw materials and finished products by screening.	1.	Measurement of volume surface mean diameter, mass mean diameter, number of particles using a Sieve shaker.	CO-1
<i>LSO 2.1.</i> Select appropriate screening equipment's. <i>LSO 2.2.</i> Identify the Overflow and underflow material for a screen.	2.	Evaluation of the overall effectiveness of given screening equipment.	CO-3
<i>LSO 3.1.</i> Select appropriate size reduction equipments for given material. <i>LSO 3.2.</i> Evaluate the reduction ratio done by a jaw crusher.	3.	Screen analysis of mixture obtained from a jaw crusher.	CO-3
<i>LSO 4.1.</i> Analysis the effect of Residence time on the on the grinding efficiency of a ball mill. <i>LSO 4.2.</i> Compare the reduction ratio done by the Jaw Crusher & Ball Mill.	4.	Determination of Variation of size reduction in Ball Mill by changing the residence time.	CO-2
<i>LSO 5.1.</i> Apply crushing laws in size reduction operation.	5.	Evaluation of the Rittinger's constant for the laboratory Jaw Crusher.	CO-2, CO-3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 5.2.</i> Select appropriate size reduction equipment for given material.			
<i>LSO 6.1.</i> Estimate the separation achieved in the Solid – gas mixture. <i>LSO 6.2.</i> Compare separation achieved by different separation equipment.	6.	Measurement of efficiency of separation in Cyclone Separator.	CO-3,
<i>LSO 7.1.</i> Select appropriate equipment used for separation of solid in Solid -Liquid mixture. <i>LSO 7.2.</i> Compare separation achieved by different separation equipment.	7.	Measurement of efficiency of separation in Froth Flotation Cell.	CO-3,
<i>LSO 8.1.</i> Choose suitable Separation equipment for magnetic material.	8.	Measurement of efficiency of separation in Electrostatic Separator.	CO-3,
<i>LSO 9.1.</i> Operate different types of filters. <i>LSO 9.2.</i> Compare performance and uses of different types of filters.	9.	Measurement of cake resistance, filter media resistance in pressure filtration.	CO-3, CO-4
<i>LSO 10.1.</i> Operate different types of filters. <i>LSO 10.2.</i> Compare performance and uses of different types of filters.	10.	Measurement of rate of filtration, filter medium & cake resistance in Gravity Filtration.	CO-3, CO-4
<i>LSO 11.1.</i> Apply various factors affecting motion of solid in fluid. <i>LSO 11.2.</i> Control agitation process for different flow pattern.	11.	Determination of Reynold's no. and relate the power number with Reynold's number in an Agitated System.	CO-5

L) **Suggested Term Work and Self Learning: S2414304** 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 such as:

- i. Find the critical speed of a ball mill.
- ii. Draw the neat and clean sketch of Jaw crusher & Ball mill.
- iii. Measure the rate of filtration in candle filter used in house hold.

b. **Micro Projects:**

1. Visit a municipal waste water treatment plant and prepare brief report on filtration technique used in plant.
2. Visit a nearby cement industry and prepare a brief report on different type of size reduction equipment used in the industry.
3. Develop Working model of any mechanical operation equipment in cost effective manner.
4. Visit a nearby any construction site and prepare a brief report on the importance and use of different screening equipment used in construction process.

c. **Other Activities:**

1. Seminar Topics:
 - Importance of Manually Total Dissolved Salts (MTDS) controller in water purifier.
 - Importance of Ultra Filtration (UF) equipment used in water purifier.
 - Importance of Ultra Violet (UV) equipment used in water purifier.

2. Visits: Visit nearby fertilizer/cement/dairy/refinery industries and make a detail report on role of different type of mechanical operation equipment used in that industry.
3. Self-Learning Topics:
 - Comparison of particulate solid and bulk solid.
 - Application of different crushing and grinding equipment.
 - Application of cyclone separator and ESP.
 - Difference between different types of filter medium used in filtration process.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	10%	5%	10%	15%	15%
CO-2	30%	30%	30%	25%	15%	30%	30%
CO-3	10%	10%	10%	25%	30%	30%	30%
CO-4	30%	30%	30%	30%	30%	15%	15%
CO-5	20%	20%	20%	15%	15%	10%	10%
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 Properties and Storage of Solids	6	CO1	7	2	2	3
Unit-2.0 Size reduction and Separation of Solids	14	CO2, CO3	21	7	6	8
Unit-3.0 Separation of Solids Based on Specific Properties	8	CO3	7	2	2	3
Unit-4.0 Filtration and Sedimentation	10	CO4	21	5	8	8
Unit-5.0 Mixing and Agitation	10	CO5	14	4	4	6
Total	48	-	70	20	22	28

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

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Measurement of volume surface mean diameter, mass mean diameter, number of particles using a Sieve shaker.	CO-1	30	60	10
2.	Evaluation of the overall effectiveness of given screening equipment.	CO-3	40	50	10
3.	Screen analysis of mixture obtained from a jaw crusher.	CO-3	30	60	10
4.	Determination of Variation of size reduction in Ball Mill by changing the residence time.	CO-2	30	60	10
5.	Evaluation of the Rittinger's constant for the laboratory Jaw Crusher.	CO-2, CO-3	30	60	10
6.	Measurement of efficiency of separation in Cyclone Separator.	CO-3	30	60	10
7.	Measurement of efficiency of separation in Froth Flotation Cell.	CO-3	30	60	10
8.	Measurement of efficiency of separation in Electrostatic Separator.	CO-3	40	50	10
9.	Measurement of cake resistance, filter media resistance in pressure filtration.	CO-3, CO-4	40	50	10
10.	Measurement of rate of filtration, filter medium & cake resistance in Gravity Filtration.	CO-3, CO-4	40	50	10
11.	Determination of Reynold's no. and relate the power number with Reynold's number in an Agitated System.	CO-5	30	60	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

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

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

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

S. No.	Name of Equipment, Tools, and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Sieve Shaker	Set of sieve 200 mm dia. And 35 mm height of each sieve should conform to ASTM. The sieves designation should best- 850,600,425,300,212,106,75 micron with lid and receiving pan.	All
2.	Jaw Crusher	Jaw: Size 100 x 150mm. Feed Hopper: Suitable capacity. Feed Size: 50mm (approx.) Product Discharge Size: (5-15) mm (approx.) Drive: Electric motor, 3 HP, Single phase	3,5

S. No	Name of Equipment, Tools, and Software	Broad Specifications	Relevant Experiment/Practical Number
3.	Ball Mill	Ball Mill: Material MS, Dia. 275mm, Length 350mm. Thickness 4 mm (approx.) Discharge Chute: Suitable size. Feed Size: 6 mm (approx.) Product Size: 200 mesh (approx.) Drive: 1 HP motor	4
4.	Cyclone Separator	A cyclone separator made in glass with cylinder portion 6" diameter ,150 mm height, tapering to 40 mm diameter in 200 mm length with 40 mm 2. tangential entry for gas solid mixture. Pressure tapping at suitable location with manometer	6
5.	Vibrator Screen	Vibrating Screen (3 Nos.): Width 380mm, Length 600mm. Mesh: Size - 12.7mm, 9.5mm and 6.3mm (Approx.) Drive: Eccentric shaft coupled to motor Electric Supply: Single phase, 220 V AC, 50 Hz, 5-15 amp with Electronic Weighing Balance: capacity 2 kg (least count 1 gm) Feed Hopper: Compatible Capacity with arrangement to control feed. Collecting bins: 4 Nos. of suitable capacity. Control Panel comprises of: Standard make on off switch, Mains Indicator etc.	All
6.	Plate and Frame Filter press	Plate size-200mm×200mm, filter cake capacity-19 cubic feet , filtration area-1.7 feet square, feed rate-8 to 1.7 GPM, slurry pressure-60 psi.	9,10
7.	Tumbler Mixer	Method Type: Free Rolling Usage: Textile Testing Instrument Vacuum Level:22 Inch Voltage:240V Frequency:50 Hz Power Source: Electric	11

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Unit Operations of Chemical Engineering	McCabe and Smith	McGraw Hill Publications, New Delhi, Seven, ISBN-10: 9339213238
2.	Introduction to Chemical Engineering	Badger and Benchro	McGraw Hill Publications, New Delhi, Indian Edition 2017 ISBN-10: 0074630504
3.	Unit Operation Vol.-I	K.A.Gavhane	Nirali Prakashan, Thirtieth Edition, ISBN: 9788196396114, 9788196396114
4.	Mechanical Operations	Swain A.K., G.K.Roy	McGraw Hill Education India ,3rd edition, 2016 ISBN: 9780070700222, 0070700222

(b) Online Educational Resources:

1. <https://ndl.iitkgp.ac.in>
2. <https://onlinecourses.nptel.ac.in>
3. <https://swayam.gov.in/explorer>
4. <https://www.classcentral.com/course/swayam-mechanical-unit-operations-14193>
5. <http://www.cheresources.com>
6. <https://learncheme.com>

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. Literature available in any laboratory manual of Mechanical Operation.
2. NPTEL
3. MIT Open course lecture available on Internet etc.

- 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. <p>3.2 Lists:</p>	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>	<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. 	CO-5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	<ul style="list-style-type: none"> Demonstration of the difference between one-dimensional and multi-dimensional array indexing. 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	
<p><i>TSO 6a.</i> Explain different types of Exceptions in python</p> <p><i>TSO 6b.</i> Write Python programs for exception handling in Python</p> <p><i>TSO 6c.</i> Differentiate different modes of file opening.</p> <p><i>TSO 6d.</i> Perform read, Write, Append operations in files</p>	<p>Unit 6: Exception and File Handling in Python</p> <p>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.</p> <p>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</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: P2418305

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<p><i>LSO 1.1.</i> Write, execute and debug simple Python program using Integrated Development and Learning Environment (IDLE)</p> <p><i>LSO 1.2.</i> Write and execute simple 'C' program using variables, arithmetic expressions.</p>	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
<p><i>LSO 2.1.</i> Write and execute python programs using conditional statements.</p>	2.	Write and execute Python program to- a) Check if a Number is Positive, Negative or zero.	CO-2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 2.2.</i> Write and execute python programs using various types of Loop statements		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.	
<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 $n/(!r)*!(n-r)$ where symbol “!” stands for factorial.	CO-2, CO-4
<i>LSO 10.1.</i> Write and execute Python program to define a numpy array. <i>LSO 10.2.</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 11.1.</i> Develop and execute Python program to handle various type of exceptions. <i>LSO 11.2.</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.

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

2. 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)

3. Other Activities:

1. Seminar Topics:
 0. Tkinter widgets in python
 1. Python date/time module and its applications
 2. 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
4.	Write and execute Python program to- a) find largest number in a given list without using max().	CO-2, CO-3	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
	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.				
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 g) Write a python program to Flatten a Matrix in Python using NumPy Write a python program to Interchange two axes of an array	CO-2, CO-5	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva- Voce (%)
			PRA* (%)	PDA** (%)	
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** : 2400006(T2400006/P2400006/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>	CO3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	3.5.3 Biogas production 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: P2400006

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

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 4.1 Predict of possible factors causing effects of climate change LSO 4.2 Effect of Ice melting on sea water	4.	Assessment of the impact of climate change on local environment	CO1 CO4
LSO 5.1 Elaborate the uses of sustainable building materials, the considering 3R LSO 5.2 Trace of Carbon foot print due to construction of a small building	5.	Demonstration of sustainable building materials in lab/workshop	CO2 CO5
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
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 recourses before use by the students.

(c) Others:

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

- A) **Course Code** : 2414306(P2414306/S2414306)
 B) **Course Title** : Summer Internship -I (Common For all Programmes)
 C) **Pre- requisite Course(s)** :
 D) **Rationale** :

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

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

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

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

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

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2414306	Summer Internship -I	-	-	02	02	04	02

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2414306	Summer Internship -I	-	-	10	15	10	15	50

Legend:

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

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

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

Note:

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

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

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

J) Assessment of Summer Internship -I

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

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

- A) **Course Code** : 2400007(T2400007)
 B) **Course Title** : Indian Constitution (Common for all Programmes)
 C) **Pre- requisite Course(s)** :
 D) **Rationale** :

This course will focus on the basic structure and operative dimensions of Indian Constitution. It will explore various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian Constitution. The Constitution of India is the supreme law of India. The document lays down the framework demarcating the fundamental political code, structure, procedures, powers, and sets out fundamental rights, directive principles, and the duties of citizens. The course on constitution of India highlights key features of Indian Constitution that makes the students a responsible citizen. In this online course, we shall make an effort to understand the history of our constitution, the Constituent Assembly, the drafting of the constitution, the preamble of the constitution that defines the destination that we want to reach through our constitution, the fundamental right constitution guarantees through the great rights revolution, the relationship between fundamental rights and fundamental duties, the futurist goals of the constitution as incorporated in directive principles and the relationship between fundamental rights and directive principles.

- E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course out comes 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** Enumerate salient features and characteristics of the constitution of India.
CO-2 Follow fundamental rights and duties as responsible citizen and engineer of the country.
CO-3 Analyze major constitutional amendments in the constitution.

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	-	-		
CO-2	1	-	-	-	2	-	-		
CO-3	1	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				
2400007	Indian Constitution	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)	
2400007	Indian Constitution	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: T2400007

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain the meaning of preamble of the constitution.</p> <p><i>TSO 1b.</i> List the salient features of constitution.</p> <p><i>TSO 1c.</i> List the characteristics of constitution.</p>	<p>Unit-1.0 Constitution and Preamble</p> <p>2.1 Meaning of the constitution of India.</p> <p>2.2 Historical perspective of the Constitution of India.</p> <p>2.3 Salient features and characteristics of the Constitution of India.</p> <p>2.4 Preamble to the Constitution of India.</p>	CO1
<p><i>TSO 2a.</i> Enlist the fundamental rights.</p> <p><i>TSO 2b.</i> Identify fundamental duties in general and in particular with engineering field.</p> <p><i>TSO 2c.</i> Identify situations where directive principles prevail over fundamental rights.</p>	<p>Unit-2.0 Fundamental Rights and Directive Principles</p> <p>2.1 Fundamental Rights under Part-III.</p> <p>2.2 Fundamental duties and their significance.</p> <p>2.3 Relevance of Directive Principles of State Policy under part-IV.</p>	CO2
<p><i>TSO 3a.</i> Enlist the constitutional amendments.</p> <p><i>TSO 3b.</i> Analyze the purposes of various amendments.</p>	<p>Unit-3.0 Governance and Amendments</p> <p>3.1 Amendment of the Constitutional Powers and Procedure</p> <p>3.2 Major Constitutional Amendment procedure - 42nd, 44th, 74th, 76th, 86th and 91st</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: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Role of Media in Spreading Awareness regarding Fundamental Rights
2. Analysis of Situations where directive principle of State policy has prevailed over Fundamental rights
3. Analyze 42nd and 97th Amendment of Indian Constitution

c. Other Activities:

1. Seminar Topics:
 - Democracy and Political Participation in India
 - Situations where directive principles prevail over fundamental rights.
2. Visits:
 - Arrange Mock Parliament.
3. Design games and simulation on emergencies declared in last thirty years.
4. Group discussions on current print articles.
 - Adoption of Article 365 in India.
 - Need of amendments in the constitution.
5. Prepare collage/posters on current constitutional issues.

- Emergencies declared in India
- Seven fundamental rights

6. Cases: Suggestive cases for usage in teaching:

Case	Relevance
A.K. Gopalan Case (1950)	SC contended that there was no violation of Fundamental Rights enshrined in Articles 13, 19, 21 and 22 under the provisions of the Preventive Detention Act, if the detention was as per the procedure established by law. Here, the SC took a narrow view of Article 21.
Shankari Prasad Case (1951)	This case dealt with the amendability of Fundamental Rights (the First Amendment's validity was challenged). The SC contended that the Parliament's power to amend under Article 368 also includes the power to amend the Fundamental Rights guaranteed in Part III of the Constitution.
Minerva Mills case (1980)	This case again strengthens the Basic Structure doctrine. The judgement struck down 2 changes made to the Constitution by the 42nd Amendment Act 1976, declaring them to violate the basic structure. The judgement makes it clear that the Constitution, and not the Parliament is supreme.
Maneka Gandhi case (1978)	A main issue in this case was whether the right to go abroad is a part of the Right to Personal Liberty under Article 21. The SC held that it is included in the Right to Personal Liberty. The SC also ruled that the mere existence of an enabling law was not enough to restrain personal liberty. Such a law must also be "just, fair and reasonable."

7. Self-Learning Topics:

- Parts of the constitution and a brief discussion of each part.
- Right to education.
- Right to equality.

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%	-	-	-	-
CO-2	40%	-	40%	50%	50%	-	-
CO-3	30%	-	30%	50%	50%	-	-
Total Marks	25	-	5	10	10	-	-
			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: (Not Applicable)

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	The Constitution of India	P.M.Bakshi	Universal Law Publishing, New Delhi 15th edition, 2018, ISBN: 9386515105
2.	Introduction to Indian Constitution	D.D.Basu	Lexis Nexis Publisher, New Delhi, 2015, ISBN:935143446X
3.	Introduction to Constitution of India	B. K. Sharma	PHI, New Delhi, 6th edition, 2011, ISBN:8120344197
4.	The Constitution of India	B.L. Fadia	Sahitya Bhawan, Agra, 2017, ISBN:8193413768
5.	The Constitutional Law of India	Durga Das Basu	LexisNexis Butterworths Wadhwa, Nagpur 978-81-8038-426-4

(b) Online Educational Resources:

- <https://www.coursera.org/learn/principles-of-management>
- <http://www.legislative.gov.in/constitution-of-india>
- https://en.wikipedia.org/wiki/Constitution_of_India
- <https://www.india.gov.in/my-government/constitution-india>
- <https://eci.gov.in/about/about-eci/the-setup-r1/>
- <https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/>
- <https://main.sci.gov.in/constitution>
- <https://nios.ac.in/media/documents/srsec317newE/317EL8.pdf>
- <https://legallaffairs.gov.in/sites/default/files/chapter%203.pdf>
- https://www.concourt.am/armenian/legal_resources/world_constitutions/constit/india/india-e.htm
- <https://constitutionnet.org/vl/item/basic-structure-indian-constitution>

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** : 2400107(T2400107)
- B) **Course Title** : Professional Ethics
(CE, CSE, ELX, ELX (R), FTS, ME, AIML, MIE, CHE, CRE, FPP, GT, EE, AE, CACDDM)
- C) **Pre- requisite Course(s)** : General awareness about moral values and different workplaces
- D) **Rationale** :

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

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

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

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

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

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

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

- F) **Suggested Course Articulation Matrix (CAM):**

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

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

* PSOs will be developed by 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			
2400107	Professional Ethics	01	-	-	01	01

Legend:

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

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)	
2400107	Professional Ethics	25	-	-	-	-	-	25

Legend:

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

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

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

Note:

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

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: T2400107

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

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

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

- a. **Assignments:** Preparation for group discussion, panel discussion, role play, case study, seminar, skits
- b. **Micro Projects:** Skits development and performance, poster making,
- c. **Activities: Role Play, Case studies, Debates, Group Discussion,**
- d. Suggested Seminar/ Debates on Topics such as:
 - i. charters of professions
 - ii. Importance of Values and ethics in identified profession
 - iii. Issues of ethical conflicts- Professional rivalry,
 - iv. Identified issues from Chanakya Neeti
 - v. Ethics in scriptures such as Kabir ke Dohe etc.
 - vi. Lessons on ethics from religious scriptures
 - vii. Issued based on Happenings reported in Daily news

L) Suggested Instructional/Implementation Strategies: Different instructional or implementation strategies may be appropriately selected based on the requirements of the content or outcomes. Examples include

improved lectures, the case method, group discussions, seminars, role play, live demonstrations in classrooms or labs, expert sessions, video clippings, and the use of open educational resources (OER) and MOOCs.

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

N) Suggested Learning Resources:

(a) Books:

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

(b) Online Educational Resources:

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