Curriculum of Diploma Programme

in

Ceramics 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				
2413301	**PCC**	**Basic Refractory Tech**	3	-	4	2	9	6
2413302	**PCC**	**Ceramics and Raw Materials**	2	1	-	2	5	4
2413303	**PCC**	**Basic Glass Tech.**	3	-	4	2	9	6
2413304	**PCC**	**Enamel Tech.**	3	-	4	2	9	6
2418305	**BCC**	**Python Programming** (CE, CSE, AIML, EE, ME, ME (Auto)., ELX, ELX (R), MIE, FTS, CRE, CHE, TE, CACDDM, GT)	3	-	4	2	9	6
2413306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	1	1	2	2
Total			**14**	**1**	**17**	**11**	**43**	**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)	
2413301	**PCC**	**Basic Refractory Tech**	30	70	20	30	20	30	200
2413302	**PCC**	**Ceramics and Raw Materials**	30	70	20	30	-	-	150
2413303	**PCC**	**Glass Tech.**	30	70	20	30	20	3 0	200
2413304	**PCC**	**Enamel Tech.**	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
2413306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	10	15	10	15	50
Total			**150**	**350**	**110**	**165**	**90**	**135**	**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**	**: 2413301(T2413301/P2413301/S2413301)**
B)	**Course Title**	: Basic Refractory Technology
C)	**Pre- requisite Course(s)**	: Applied Chemistry
D)	**Rationale**	:

Basic Refractory Technology is an important course, which deals with heat resistant materials and products. Refractory is an essential material used in all kinds of furnaces and therefore knowledge of this technology is vital for ceramic engineers. It also provides an opportunity to know various Kilns/furnaces used in Ferrous and Non - Ferrous industries besides its use in Ceramic industries. It is an essential foundation for Advance Refractory Technology course in higher semester.

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 Enumerate the properties of refractories and industrial use.
CO-2 Select suitable refractory for given situations.
CO-3 Select relevant raw material for refractory product development.
CO-4 Use appropriate machinery for refractory material processing.
CO-5 Prepare refractory of lab scale using different methods which are economic and environmentally sustainable.

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		
CO-2	3	2	1	1	1	-	1		
CO-3	3	2	3	2	2	-	1		
CO-4	3	2	2	3	1	1	1		
CO-5	3	2	3	3	3	3	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				
2413301	Basic Refractory Technology	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)	
2413301	Basic Refractory Technology	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (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, microprojects, 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: T2413301

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe Refractory with examples. *TSO 1b.* List out the criteria of materials for refractories. *TSO 1c.* Explain status of refractory application in various industries.	**Unit-1.0 Introduction to Refractories** 1.1 Definition of Refractory 1.2 Basic Properties Requirement of Refractories. 1.3 Role of Refractories 1.4 History of Refractory Development 1.5 Scope of Refractories in various industries	**CO1**
TSO 2a. Classify refractories on given criteria. *TSO 2b.* Differentiate acidic, basic, and neutral refractory. *TSO 2c.* Describe special refractory.	**Unit-2.0 Classification of Refractory** 2.1 Based on Chemical Nature 2.2 Based on Manufacturing Method 2.3 Based on Physical Form 2.4 Based on Porosity 2.5 Based on Application Temperature 2.6 Special Refractory	**CO1, CO2**
TSO 3a. Differentiate natural occurring raw materials and synthetic raw materials. *TSO 3b.* Explain properties of given refractory raw materials. *TSO 3c.* Select raw materials for specific refractory manufacturing.	**Unit-3.0 Refractory Raw Materials** 3.1 Types of Raw Materials: Natural and Synthetic refractory raw materials 3.2 Occurrence, Physical, Chemical properties, Effect of temperature, applications of Refractory Raw Materials: Silica, Fire Clay, Alumino-Silicate 3.3 Properties and Uses of Magnesite, Dolomite, Chromite 3.4 Properties and Uses of Bauxite, Alumina 3.5 Synthesis: Alumina, Calcined Alumina, Tabular Alumina, White Fused Alumina, Sintered Alumina, Zirconia, Graphite	**CO3, CO4**
TSO 4a. Identify various methods for raw material processing. *TSO 4b.* List machineries for crushing, grinding, separation, mixing and pressing. *TSO 4c.* Explain working principle of machineries for crushing, grinding, separation, mixing and pressing.	**Unit-4.0 Processing of Raw Materials** 4.1 Methods of crushing, grinding, mixing of refractory materials. 4.2 Working Principle of machines used for crushing and grinding of refractory materials: Jaw Crusher, Cone Crusher, Disintegrator, Ball Mill 4.3 Working Principle of for separation of refractory materials: Screens, Magnetic Separator. 4.4 Working Principle of machines for mixing: Pug Mill, Muller mixer, Pan Mill 4.5 Working Principle of machine for pressing: Toggle Press, Screw Press, Hydraulic Press	**CO3, CO4**
TSO 5a. Select suitable method for shaping of refractory. *TSO 5b.* Explain drying and firing process for given refractory. *TSO 5c.* Explain working principle of machineries for drying and firing.	**Unit-5.0 Manufacturing Methods of Refractory** 5.1 Shaping of refractory by pressing, extrusion, Casting 5.2 General principles of drying and Firing 5.3 Dryers used for Drying refractory bricks. 5.4 Kilns used for firing refractory bricks.	**CO4, CO5**

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

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

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use Jaw crusher and ball mill. *LSO 1.2.* Prepare silica raw materials for refractory making.	1.	Crushing and grinding of Silica using jaw Crusher and Ball mill.	CO1, CO3, CO4
LSO 2.1. Use Jaw crusher and ball mill. *LSO 2.2.* Prepare fire clay raw materials for refractory making.	2.	Crushing and grinding of Fire Clay using jaw Crusher and Ball mill.	CO1, CO3, CO4
LSO 3.1. Use Jaw crusher and ball mill. *LSO 3.2.* Prepare alumina for refractory making.	3.	Crushing and grinding of Alumina using jaw Crusher and Ball mill.	CO1, CO3, CO4
LSO 4.1. Use Jaw crusher and ball mill. *LSO 4.2.* Prepare magnesite for refractory making.	4.	Crushing and grinding of Magnesite using jaw Crusher and Ball mill.	CO1, CO3, CO4
LSO 5.1. Use the mould and pressing machine. *LSO 5.2.* Produce shaped refractory bricks.	5.	Hand molding and pressing of refractory.	CO3, CO4, CO5
LSO 6.1. Operate dryer for drying of refractory. *LSO 6.2.* Select Suitable temperature for drying.	6.	Air and oven drying of refractory.	CO3, CO4, CO5
LSO 7.1. Select appropriate klin for firing of refractory. *LSO 7.2.* Operate electric kiln for firing. *LSO 7.3.* Select suitable temperature for firing of refractory.	7.	Firing of refractory in electric kiln.	CO3, CO4, CO5

L) Suggested Term Work and Self Learning: S2413301 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 like-

1. Collection of different raw materials used in the Refractory industry.
2. List out different Refractory products used in various Industry.
3. Collect image/diagram of different shape and size of refractories used in various industries.
4. Download videos on working principle of different equipment used in refractory industries.

b. Micro Projects:

1. Prepare a report on specific refractory materials used in industrial applications such as alumina-based refractories.
2. Compare two different classification systems used for categorizing refractory materials based on chemical composition, physical properties and make a report.
3. Prepare a report by selecting a specific raw material used in refractory manufacturing such as alumina, magnesia or silica and conduct a comprehensive analysis of the raw materials including its chemical composition and physical properties.
4. Prepare a comparative report on different processing methods such as crushing, grinding, mixing in terms of their effectiveness, energy consumption and environmental impact.

c. Other Activities:

1. Seminar Topics:

   - Commercially available refractory raw materials in India.
   - Refractory export and import in India.
   - Major application areas of refractory.

2. Visits:

   Visit nearby industry of bricks manufacturing. Prepare report of visit with special comments of material used for bricks manufacturing, process applied, major application area, major consumer, costing.

3. Self-Learning Topics:

   - Insulating lining of furnace.
   - Working lining of furnace.
   - Component of a furnace.
   - Presence of refractory raw material in India

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**.

<table>
<tr><th rowspan="4">COs</th><th colspan="7">Course Evaluation Matrix</th></tr>
<tr><th colspan="2">Theory Assessment (TA)**</th><th colspan="3">Term Work Assessment (TWA)</th><th colspan="2">Lab Assessment (LA)#</th></tr>
<tr><th rowspan="2">Progressive Theory Assessment (PTA) Class/Mid Sem Test</th><th rowspan="2">End Theory Assessment (ETA)</th><th colspan="3">Term Work& Self Learning Assessment</th><th rowspan="2">Progressive Lab Assessment (PLA)</th><th rowspan="2">End Laboratory Assessment (ELA)</th></tr>
<tr><th>Assignments</th><th>Micro Projects</th><th>Other Activities*</th></tr>
<tr><td>CO-1</td><td>10%</td><td>10%</td><td>15%</td><td>-</td><td>-</td><td>10%</td><td>10%</td></tr>
<tr><td>CO-2</td><td>20%</td><td>15%</td><td>10%</td><td>25%</td><td>10%</td><td>-</td><td>-</td></tr>
<tr><td>CO-3</td><td>20%</td><td>20%</td><td>15%</td><td>25%</td><td>20%</td><td>20%</td><td>30%</td></tr>
<tr><td>CO-4</td><td>30%</td><td>30%</td><td>30%</td><td>25%</td><td>35%</td><td>30%</td><td>40%</td></tr>
<tr><td>CO-5</td><td>20%</td><td>25%</td><td>30%</td><td>25%</td><td>35%</td><td>40%</td><td>20%</td></tr>
<tr><td rowspan="2">Total Marks</td><td rowspan="2">30</td><td rowspan="2">70</td><td>20</td><td>20</td><td>10</td><td rowspan="2">20</td><td rowspan="2">30</td></tr>
<tr><td colspan="3">50</td></tr>
</table>

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Refractories	6	CO1	7	3	4	-
Unit-2.0 Classification of Refractory	8	CO1, CO2	10	3	4	3
Unit-3.0 Refractory Raw Materials	10	CO3	14	5	4	5
Unit-4.0 Processing of Raw Materials	13	CO3, CO4	21	5	6	10
Unit-5.0 Manufacturing Methods of Refractory	11	CO4, CO5	18	4	7	7
Total	**48**	**-**	**70**	**20**	**25**	**25**

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

O) Suggested AssessmentTable for Laboratory (Practical): P2413301

S.No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Crushing and grinding of Silica using jaw Crusher and Ball mill.	CO1, CO4	30	60	10
2.	Crushing and grinding of Fire Clay using jaw Crusher and Ball mill.	CO1, CO4	30	60	10
3.	Crushing and grinding of Alumina using jaw Crusher and Ball mill.	CO1, CO4	30	60	10
4.	Crushing and grinding of Magnesite using jaw Crusher and Ball mill.	CO1, CO4	30	60	10
5.	Hand molding and pressing of refractory.	CO3, CO4, CO5	40	50	10
6.	Air and oven drying of refractory.	CO3, CO4, CO5	30	60	10
7.	Firing of refractory in electric kiln.	CO3, CO4, CO5	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.	Laboratory Jaw Crusher	Laboratory Type, High crushing efficiency, feed sizes up to 40 mm can be crushed to 0.5 mm, Removable jaw for easy cleaning, Adjustable speed, Wear compensation with zero-point adjustment, Convenient operating keypad with digital display, Memory for gap width setting. Capacity- 100-200 kg/hours, 440 **volts**, 3 phase	1,2,3,4
2.	Laboratory Ball Mill	Laboratory Type, Max. speed 650 rpm Up to 10 mm feed size and 0.1 µm final fineness 1 grinding station for jars from 12 ml up to 500 ml Jars of 12 – 80 ml can be stacked (two jars each) Grind Control to measure temperature and pressure inside the jar. Aeriation lids to control the atmosphere inside the jar. Storable SOPs and cycle programs, 5 different jar materials for dry and wet grinding Capacity- 5 to 10 kg, Rotation speed- 30-80 rpm,2 HP, 220 volt	1,2,3,4
3.	Table Top Sieve Shaker	Capacity- 2 kg, Measurement range from 5 µm to 63 mm, volt -220	1,2,3,4
4.	Refractory Brick Mould Die	Made of steel, Size- 230*115*75 mm, 125*50*50 mm	5
4.	Pressing Machine	Laboratory Type	5
5.	Electric Dryer	Temperature Range- 50-200^{o} C, Size-18''*18''*18''	6,7
6.	Electric Furnace	Temperature Range- 1600^{o}C-2000^{o}C, Size of chamber – 18''*18''*18''	6,7

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Ceramic Materials Formation	R. P. Sinha	Novelty; 2nd Edition, ASIN : B083W91KDL
2.	Refractory Technology Fundamentals and Applications	Ritwik Sarkar	CRC Press, 1st edition, ISBN-13 :978-1498754255
3.	Introduction to Refractories for Iron and Steel Making	Subir Biswas Debasish Sarkar	Springer NatureSwitzerlandAG, ISBN-10 : 3030438066
4.	Refractory material selection for steelmaking	Dr. Jeff Smith	Wiley-American Ceramic Society , ISBN-10 : 1119219868
5.	Steel Plant Refractory	J.H. Chesters	W P (1 January 2005), ISBN-13: 978-1845691202
6.	Refractories	F. H. Norton	McGraw-Hill, ISBN-10 : 0070475385

(b) Online Educational Resources:

1. http://www.nitttrc.edu.in/nptel/courses/video/113104008/L39.html
2. https://en.wikipedia.org/wiki/Refractory
3. https://en.wikipedia.org/wiki/Refractory#Classification_of_refractory_materials

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. Users' Guide
2. Material Handbook
3. Lab Manuals
4. Refractories and Their Manufacture, Properties and Uses_ M. L. Mishra
5. Handbook on Refractories_ D. N. Nandi

*****

A) Course Code : **2413302(T2413302/S2413302)**
B) Course Title : Ceramics and Raw Materials
C) Pre- requisite Course(s) : Applied Chemistry
D) Rationale :

Ceramic Graduates works in various industries for products developments and application. This course on Ceramics and Raw materials provides idea about occurrence and properties of different ceramic materials. So this helps to select the appropriate materials for products developments and application of particular products in various aspects. It also provide the students with comprehensive understanding of various ceramic materials including pottery, refractory, glass, and other raw materials. By exploring the properties and applications of the raw materials the students will be well equipped to contribute to the ceramic industry.

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

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

CO-1 Choose relevant raw materials for various products of ceramics.
CO-2 Choose ecological, cost-effective pottery raw materials for product development**.**
CO-3 Select industrial materials using knowledge of naturally occurring refractory raw materials.
CO-4 Propose alternative raw materials for specific glass making.
CO-5 Select appropriate non-oxide ceramic raw materials for product development.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme SpecificOutcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development 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	-	1	1	1		
CO-3	3	1	2	1	2	1	1		
CO-4	3	1	2	-	-	-	1		
CO-5	3	1	3	1	2	3	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				
2413302	Ceramics and Raw Materials	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)	
2413302	Ceramics and Raw Materials	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: T2413302

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe ceramic products with examples. *TSO 1b.* List out the material for refractory/pottery/glass/enamel/cement. *TSO 1c.* Explain status of refractory application in various industries	**Unit-1.0 Ceramics Products and Raw Materials** 1.1 Definition of Ceramic 1.2 History of Ceramic 1.3 Refractory and their raw materials 1.4 Pottery and their raw materials 1.5 Glass and their raw materials 1.6 Enamel and their raw materials 1.7 Cement and their raw materials 1.8 Electrical and other products and their raw materials.	**CO1**
TSO 2a. Identify different silicates and their structure. *TSO 2b.* Identify key characteristics of Silicates. *TSO 2c.* Describe pottery raw materials. *TSO 2d.* Differentiate between Gypsum, Plaster of Paris, Wollastonite. *TSO 2e.* Prepare batch for pottery. *TSO 2f.* Select fluxing raw materials for given ceramic process.	**Unit-2.0 Pottery Raw Materials** 2.1 Silicate: formation, structure, action of heat, properties, uses 2.2 Clay: formation, classification, structure, action of heat, properties, uses 2.3 Fluxing Raw Materials: Feldspar, Talc, Nepheline Syenite. 2.4 Gypsum, Plaster of Paris, Wollastonite, Coloring Materials: metal oxides, Stains, Underglazes, Glazes, Lusters, Engobes, Raku Glazes.	**CO2**
TSO 3a. List natural occurring raw materials and synthetic raw materials. *TSO 3b.* Demonstrate the use of natural refractory raw materials in the production of refractory Products. *TSO 3c.* Explain properties of given refractory raw materials. *TSO 3d.* Explain the steps involved in synthesis of Alumina, Zircon and Graphite	**Unit-3.0 Refractory Raw Materials** 3.1 Raw Materials: Naturally occurring raw materials and synthetic raw materials. 3.2 Natural Raw materials: Uses and Properties of Fire Clay, Bauxite, Magnesite, Dolomite, Chromite, Graphite, Zirconia. 3.3 Synthetic raw materials: Uses and Properties of Alumina-Silica, Mullite, Calcium aluminate cement, Magnesia Chrome 3.4 Synthesis of Alumina, Zircon, Graphite	**CO3**
TSO 4a. Identify various materials used for glass making. *TSO 4b.* Describe the properties and characteristics of Silica Sand, Calcite, Soda, Boron Oxide, Bone ash, Lead Oxide. *TSO 4c.* Explain low temperature glass making materials.	**Unit-4.0 Glass Raw Materials** 4.1 Raw Materials: Properties and Uses of Silica Sand, Calcite, Soda, Boron Oxide, Bone ash, Lead Oxide.	**CO4**
TSO 5a. Select suitable material for modern and advanced ceramics. *TSO 5b.* List out the application of non-oxide ceramics materials. *TSO 5c.* Explain synthesis and properties of advanced ceramics.	**Unit-5.0 Modern and Advanced Ceramics** 5.1 Synthesis, Uses and properties of Silicon Carbide, Silicon Nitride, Barium Titanate, Carbon-Carbon Composite, Titanium Diboride, Lithium Aluminosilicates.	**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: S2413302 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

1. Prepare a report on different synthesis and processing techniques used for ceramics.
2. Prepare a report by selecting suitable ceramic materials for specific applications, justify your choice based on material properties and cost effectiveness and environmental considerations.
3. Collection of different raw materials from nearby industries/shops and prepare a report and present in the class

b. Micro Projects:

1. Explore different raw materials used in nearby Industry and prepare a report.
2. Prepare a report by collecting pictures of different ceramics products for various purposes.
3. Students can work in a small group to design a prototype of a ceramic product using appropriate raw materials and prepare a report on the same.
4. Prepare a report by analyzing the real-world case studies of advanced ceramics applications and evaluate the challenges faced and advantages offered by using advanced ceramics.
5. Download videos on mining of different raw materials and represent the mining of various raw materials in the classroom.

c. Other Activities:

1. Seminar Topics:
   - Naturally occurring raw materials and synthetic raw materials in India.
   - Raw materials import and export in India.
   - Major application areas of ceramics.
   - Advance Ceramic / Modern Ceramic
   - Ceramics in Medical Sector
   - Invite experts from ceramic industry, academia, or research institutions to give lectures on advanced ceramics, sustainable practices and innovative applications.

2. Visits: Visit nearby industry of bricks manufacturing. Prepare report of visit with special comments of material used for bricks manufacturing, process applied, major application area, major consumer, costing.

3. Self-Learning Topics:
   - High temperature properties of materials.
   - Electrical properties of ceramics raw materials.
   - Magnetic properties of ceramics raw materials.
   - Presence of ceramic raw material in India and abroad.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	-	20%	-	-
CO-2	10%	20%	10%	25%	20%	-	-
CO-3	15%	25%	15%	25%	20%	-	-
CO-4	30%	25%	30%	25%	20%	-	-
CO-5	30%	15%	30%	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 Ceramic Products and Their Raw Materials	7	CO1	10	4	4	2
Unit-2.0 Pottery Raw Materials	10	CO2	14	4	6	4
Unit-3.0 Refractory Raw Materials	12	CO3	18	4	8	6
Unit-4.0 Glass Raw Materials	12	CO4	18	4	8	6
Unit-5.0 Modern and Advanced Ceramics	7	CO5	10	4	3	3
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(s)	Publisher and Edition with ISBN
1.	Ceramic Materials Formation	R. P. Sinha	Novelty; 2nd Edition, ASIN: B083W91KDL
2.	Refractory Technology Fundamentals and Applications	Ritwik Sarkar	Publisher: 1s CRC Press; st edition ISBN-10: 0367574292
3.	Industrial Ceramics	F. Singer and S.S. Singer	Publisher: Springer ISBN-10: 9401752591
4.	Handbook of glass technology	Dr. R. Chavan	Publisher: WileyAmerican Ceramic -Societ ISBN-10: 1119219868
5.	Refractories	F. H. Norton	Publisher : McGraw-Hill ISBN-10 : 0070475385
6.	Refractories Production and Properties	J. H. Chesters	Publisher: W.P. : ISBN-10:1845691202

(b) Online Educational Resources:

1. https://en.wikipedia.org/wiki/Ceramic
2. https://en.wikipedia.org/wiki/Ceramic_engineering
3. https://www.youtube.com/watch?v=7Be7hGvqoAg
4. https://archive.org/details/dli.ernet.239153

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

******

A) Course Code : **2413303(T2413303/P2413303/S2413303)**

B) Course Title : Glass Technology

C) Pre- requisite Course(s) : Applied Chemistry

D) Rationale :

Basic Glass Technology is an important course, which deals with glass making materials and different glass products. Glass is an essential material used in all kinds of domestic and construction applications and therefore knowledge of this technology is vital for the Ceramic Engineers. It is an essential foundation for Advance Glass Technology course in higher semester.

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 Assess the scope of glass industries in India.
CO-2 Select suitable raw materials for glass making.
CO-3 Select suitable glass for given application.
CO-4 Use different machineries for material processing in glass making.
CO-5 Use appropriate glass furnace for glass making.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme SpecificOutcomes* (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** Lifelong Learning	**PSO-1**	**PSO-2**
CO-1	3	-	-	-	1	-	1		
CO-2	3	1	-	-	-	-	1		
CO-3	3	1	-	-	-	-	1		
CO-4	3	-	-	3	3	2	1		
CO-5	3	-	2	3	3	3	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				
2413303	Basic Glass Technology	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)	
T2413303	Basic Glass Technology	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:

- Separate passing is must for progressive and end semester assessment for both theory and practical.
- 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: T2413303

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe glass with examples. *TSO 1b.* Differentiate between natural glass and synthetic glass. *TSO 1c.* Explain the properties of glass. *TSO 1d.* Explain the scope of glass industries. *TSO 1e.* Explain application of various glasses in domestic and industries.	**Unit-1.0 Glass: Overview and Scope of Glass Industry** 1.1 Glass: Definition, History of Glass Industries, Various types of Glasses 1.2 Chemical Composition of Glass 1.3 Properties and Uses of Glass 1.4 Demand and Production of Glass in India 1.5 Scope of Glass industry in India and Abroad	**CO1**
TSO 2a. Identify the sources of various glass making raw materials in India. *TSO 2b.* Classify glass making raw materials based on primary raw maetrials. *TSO 2c.* Differentiate Acidic and Basic raw materials for glass making. *TSO 2d.* Explain the role of oxidizing, reducing agents, fluxes and fining agents in glass making. *TSO 2e.* Select colouring materials for given criteria.	**Unit-2.0 Glass Making Raw Materials** 2.1 Occurrences of various glass making raw materials in India. 2.2 Classification of Glass Making Raw Materials 2.3 Essential glass forming substance. 2.4 Fluxes 2.5 Oxidizing agents 2.6 Reducing agents 2.7 Fining agents 2.8 Coloring agents and Decolourisers	**CO1, CO2**
TSO 3a. Classify glass based on batching. *TSO 3b.* Explain the properties of given glass. *TSO 3c.* Categorize specific glasses based on their composition and properties. *TSO 3d.* Select glass for a particular application. *TSO 3e.* Explain the performance and suitability of different glasses for specific applications.	**Unit-3.0 Classification of Glass** Overview, composition, properties, and uses of the following: 3.1 Soda Lime Silica Glass 3.2 Potash Lime Silica Glass 3.3 Potash Lead Glass 3.4 Borosilicate Glass 3.5 Safety Glass 3.6 Sandwich Glass 3.7 Aluminosilicate Glass 3.8 Phosphate Glass	**CO3**
TSO 4a. Identify various methods for raw material processing. *TSO 4b.* List machinery for crushing, grinding, separation, mixing. *TSO 4c.* Explain working principle of machinery for crushing, grinding, separation, mixing. *TSO 4d.* Identify batch composition and batch calculation for a given glass	**Unit-4.0 Machinery, Batching and Batch Calculation** 4.1 Storing and Preparation of Glass Materials 4.2 Sand washing, crushing of hard materials. 4.3 Magnetic separation of materials, weighing, mixing of materials. 4.4 Batch composition of different glass 4.5 Batch Calculation	**CO4**
TSO 5a. Select suitable furnaces for the glass making process. *TSO 5b.* Explain role of annealing in glass making. *TSO 5c.* Explain working principle of given furnaces for glass making.	**Unit-5.0 Glass Furnaces** 5.1 Pot Furnace 5.2 Induction Furnace 5.3 Tank Furnace 5.4 Float Glass Furnace 5.5 Electric Furnace 5.6 Annealing Furnace 5.7 Regenerator	**CO4, CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2413303

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use different sieves for sieve analysis. *LSO 1.2.* Prepare silica sand for glass making.	1.	Dry sieve analysis of silica sand.	CO1, CO2
LSO 2.1. Use different sieves for sieve analysis. *LSO 2.2.* Prepare silica sand for glass making	2.	Wet sieve analysis of silica sand.	CO1, CO2
LSO 3.1. Use Jaw crusher and Ball mill. *LSO 3.2.* Prepare soda and lime for glass making	3.	Preparation of glass batch for soda-lime silica glass.	CO1, CO2, CO4, CO5
LSO 4.1. Use Jaw crusher and Ball mill. *LSO 4.2.* Prepare potash and lime for glass making.	4.	Preparation of glass batch for potash-lime silica glass	CO1, CO2, CO4, CO5
LSO 5.1. Use of green colourants for glass making. *LSO 5.2.* Select appropriate glass making batch.	5.	Preparation of a glass batch for making green colour glass making.	CO2, CO3, CO4,CO5
LSO 6.1. Use of blue colourants for glass making. *LSO 6.2.* Select suitable glass making raw materials.	6.	Preparation of a glass batch for making blue colour glass making.	CO2, CO3, CO4, CO5
LSO 7.1. Operate kiln for melting glass batch. *LSO 7.2.* Select suitable temperature for melting glass batch.	7.	Melting of prepared glass batches.	CO4,CO5

L) Suggested Term Work and Self Learning: S2413303 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

1. Explore the Industrial applications of glasses such as borosilicate glass, optical glass, or glass-ceramics.
2. Analyse the environmental impact of glass production and propose sustainable practices for reducing energy consumption and waste generation.
3. Investigate the chemical composition of common types of glass and their respective applications.

b. Micro Projects:

1. Collect different raw materials used in glass making, categorize the same and prepare a report.
2. Collect different types of glass samples, identify the same and prepare a report on the same.
3. Prepare a report by collecting pictures of different applications of glass.
4. Prepare a report on the historical significance of glass and its impact on human civilization.
5. Interview local businesses or manufacturers to understand the factors influencing their choice of glass for specific applications and prepare a report and present in the class.

c. Other Activities:

1. Seminar Topics:
   - Glass Manufacturing Processes
   - Glass Composition and Properties
   - Smart Glass Technology
   - Nanotechnology In Glass

2. Visits: Visit a glass manufacturing facility to observe the glass production process and identify different types of glass products.

3. Self-Learning Topics:

   - Commercially available glass raw materials in India
   - Glass production and demand in India.
   - Major application areas of glass.

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

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

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Glass: Overview and Scope of Glass Industry	8	CO1	10	4	6	-
Unit-2.0 Glass Making Raw Materials	8	CO1, CO2	10	4	4	2
Unit-3.0 Classification of Glass	10	CO3	10	4	4	2
Unit-4.0 Machinery and Batching, Batch Calculation	10	CO4	21	4	7	10
Unit-5.0 Glass Furnaces	12	CO4, CO5	19	4	7	8
Total	**48**	**-**	**70**	**20**	**28**	**22**

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

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Performing Dry sieve analysis of silica sand.	CO1, CO2	30	60	10
2.	Performing Wet sieve analysis of silica sand.	CO1, CO2	30	60	10
3.	Preparation of glass batch for soda-lime silica glass.	CO1, CO2, CO4, CO5	30	60	10
4.	Preparation of glass batch for potash-lime silica glass	CO1, CO2, CO4, CO5	40	50	10
5.	Preparation of a glass batch for making green colour glass making.	CO2, CO3, CO4,CO5	40	50	10
6.	Preparation of a glass batch for making blue colour glass making.	CO2, CO3, CO4, CO5	30	60	10
7.	Performing the melting of prepared glass batches.	CO4,CO5	30	60	10

Legend:

PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semesters 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.	Electric sieve shaker machines with sieves	Measuring range*: 20 µm - 25 mm Sieving motion: throwing motion with angular momentum Amplitude: digital, 1 - 100% (0 - 3 mm) Suitable sieve diameters: 100 mm / 200 mm / 203 mm (8")	1,2,
2.	Digital Weight Balance	Can weigh upto 150 kgs with 100g Division graduation. LCD Display with digit height of 21 mm(0.8 ") along with low power and error indicator, Auto On/Off functionality, Needs to used with dry feet as the scale becomes slippery when wet, Comes with 3V Lithium cell inclided in the weighing scale	1,2,3,4,5,6
3.	Electric Oven	Fan oven: Forced convection, Max temp: 400 - 600°C, Min temp: Ambient +60°C, Volume: 30 to 120 litre	
4.	Electric kiln	1400-degree 125L electric ceramic kiln muffle furnace for sintering ceramics pottery parts	7
5.	Lab type annealing lehr	Hot air circulation annealing furnace is the most advanced glass annealing furnace. Heating up fast, especial uniform furnace temperature with no noise and no pollution. Full automatic intelligent control, with no overshoot and undershoot, precise temperature control.	7

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Ceramic Materials Formation	R. P. Sinha	Novelty; 2nd Edition, ASIN: B083W91KDL
2.	Introduction to Glass Science and Technology	James E. Shelby	Publisher: Royal Society of Chemistry; 2nd edition, ISBN-13: 978-0854046393
3.	Modern Glass Practice	S. R. Scholes	Publisher: CBI Publishing Co Inc., U.S.; 7th edition, ISBN-13 : 978-0843606126
4.	Handbook of Glass Manufacture Vol – I and II	F.V. Tooley	Publisher : Glass Industry ISBN-13 : 978-0911993226
5.	Glass Melting Tank Furnace	R. Gunther	Publisher : Society of Glass Technology ISBN-13 : 978-0900682049
6.	Coloured Glasses	W.A. Weyl	Society of Glass Technology; Seventh reprint edition (April 11, 2016), ISBN-13 : 978-0900682797

(b) Online Educational Resources:

1. https://en.wikipedia.org/wiki/Glass
2. https://en.wikipedia.org/wiki/Sand_casting#Silica_sand

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. Users' Guide of Electric kiln
2. Material Handbook for glass making
3. Handbook of Glass Technology by Dr. R. Charan
4. A Book on Glass by R.C. Srivastava
5. Lab Manuals for glass

******

A) Course Code : **2413304(T2413304/P2413304/S2413304)**

B) Course Title : Enamel Technology

C) Pre- requisite Course(s) : Applied Chemistry

D) Rationale :

Enamel Technology is an essential course, it gives knowledge of ceramic coating on metallic products. Enamel is ceramic based product which is made by fusing powder glass to a substrate by firing. It is a thin coating to provide quality and durability in products. Enamel technology is a highly specialized discipline that focuses on the precise application of enamel coatings onto diverse substrates, including but not limited to metal, glass, and ceramics. This course is crucial in equipping students with the requisite knowledge and skills to thrive in the field of enameling.

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

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

CO-1 Apply knowledge of enamel properties and raw material characteristics to select appropriate raw materials for specific enameling in industry.

CO-2 Apply appropriate techniques to prepare metal surfaces for enameling**.**

CO-3 Perform enamel fritting and milling processes.

CO-4 Apply enamel consistently and uniformly using dipping, spraying, or painting.

CO-5 Use eco-friendly procedures to make defect-free items.

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 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	1	1	1	1		
CO-3	3	1	2	3	2	1	1		
CO-4	3	1	2	3	-	2	1		
CO-5	3	1	3	1	3	3	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				
2413304	Enamel Technology	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)	
2413304	Enamel Technology	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: T2413304

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe enamel with examples. *TSO 1b.* List enamel applications. *TSO 1c.* Explain enameling future in industries. *TSO 1d.* Explain one and two component phase diagrams. *TSO 1e.* List out enamel making raw materials. *TSO 1f.* Compare enamel making raw materials.	**Unit-1.0 Raw Materials for Enamel** 1.1 Enamel: Definition History, Uses and Future 1.2 Phase Relation: Phase component-based phase diagram. 1.3 Low fusing glasses, Theory of Adherence 1.4 Properties of Enamel glass: Thermal expansion, Thermal conductivity, stress and strain, opacity 1.5 Enamel raw materials: Electrolytes, colors, opacifiers, fluxes, refractory, floating agents.	**CO1**
TSO 2a. Identify different silicates and their structure. *TSO 2b.* Prepare different metal surfaces as per need. *TSO 2c.* Perform de enameling and repairing process.	**Unit-2.0 Preparation of Metal Surfaces for Enameling** 2.1 Preparation for enameling of sheet iron and steel surface: chemical cleaning, pickling, nickel dip, pickeling accelerators, Pre- enamel Process, Blasting 2.2 Preparation of cast iron for enameling 2.3 De-enameling and repairing 2.4 Surface preparation of other metals: Aluminium, Copper, Gold, Silver, Bronze	**CO2**
TSO 3a. Explain the Importance of frit in enamel technology. *TSO 3b.* Explain Enamel milling and enamel coatings. *TSO 3c.* List the milling machines for enamel technology. *TSO 3d.* Explain enamel properties including thermal, optical, physical, mechanical strength, chemical resistance, and electrical.	**Unit-3.0 Frit, Milling, Mill addition and Enamel Properties** 3.1 Importance of Frit in Enamel Technology. 3.2 Frit making, smelters. 3.3 Enamel milling, its importance in enamel technology 3.4 Milling equipment: Construction and operation and application of Ball mill, Tube Mill 3.5 Mill addition 3.6 Enamel Properties: Thermal, Optical, Physical, Mechanical, Chemical and Electrical.	**CO3**
TSO 4a. Select suitable composition for ground coat and cover coat enamel. *TSO 4b.* Identify different process for enameling. *TSO 4c.* Explain drying and firing process for enamel wares. *TSO 4d.* Explain working principle of machineries for drying and firing.	**Unit-4.0 Enamel Composition, Application of Enamel, Drying, Firing, Dryer, and Furnaces** 4.1 Enamel composition: Ground Coat, Cover Coat. 4.2 Application of Enamel Dipping, Spraying, Brushing, Dry and Wet Process of Enameling, Decoration 4.3 Drying and Firing: Drying of Enamel wares, Firing and Firing schedule of enamel. 4.4 Dryer and Furnaces: Enamel dryer, Enamel furnaces.	**CO4**
TSO 5a. List enamel coating defects *TSO 5b.* Explain different defects in enamel products and its remedies. *TSO 5c.* Explain modern process in enameling. *TSO 5d.* Prevent and repair cast iron enamel coating problems during manufacturing.	**Unit-5.0. Enamel Defects and Modern Developments in Enamel** 5.1 Enamel Defects: Blistering, Chipping, Crazing, Fish scale, Hair lining, Rusting, Warping 5.2 Dry Process Cast Iron Enamel Defects: casting crack, crazing, Pinhole, Blister, Peeling, Torch enameling, Modern Process in Enameling	**CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2413304

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use various chemicals for surface preparation. *LSO 1.2.* Use cutting tools for cutting steel plate.	1.	Preparation of steel plate surface for enameling by pickling process.	CO1, CO2
LSO 2.1. Use various chemicals for surface preparation. *LSO 2.2.* Use cutting tools for cutting cast iron plate.	2.	Preparation of cast iron plate surface for enameling by pickling process.	CO1, CO2
LSO 3.1. Use various chemicals for surface preparation. *LSO 3.2.* Use cutting tools for cutting aluminum plate.	3.	Preparation of aluminum plate surface for enameling by pickling process.	CO1, CO2
LSO 4.1. Use different raw materials for making frit batch for ground coat. *LSO 4.2.* Use jaw crusher and ball mill for crushing and mill the batch. *LSO 4.3.* Use smelter for frit making.	4.	Preparation of a batch of frit mixture for ground coat enamel.	CO1, CO2
LSO 5.1. Use different raw materials for making frit batch for cover coat. *LSO 5.2.* Use jaw crusher and ball mill for crushing and mill the batch. *LSO 5.3.* Use smelter for frit making	5.	Preparation of a batch of frit mixture for cover coat enamel.	CO1, CO3
LSO 6.1. Use chromium oxide and cobalt oxide raw materials for making frit batch for cover coat. *LSO 6.2.* Use jaw crusher and ball mill for crushing and mill the batch.	6.	Preparation of a frit batch of cover coat green and blue color Enamel.	CO1, CO3
LSO 7.1. Select appropriate method for enameling. *LSO 7.2.* Select suitable temperature for dry and firing of enameled products. *LSO 7.3.* Use appropriate kiln for drying and Firing.	7.	Enameling on a substrate and drying and firing.	CO3, CO4

L) Suggested Term Work and Self Learning: S2413304 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

1. Compare traditional enameling with modern enameling techniques.
2. Collection of different raw materials used in Enameling.
3. List out different enameled products used in Industry and domestic purpose.
4. Collect pictures of different enamel products used in industry and domestic.

b. Micro Projects:

1. Practice enameling techniques on various substrates such as metal and prepare a report.
2. Prepare a report which showing various enamel finish, colour, and textures by explaining the formulations of enamel and their uses in various industries.
3. Prepare a report by examining enamel technology's environmental effect, including raw material utilization, fire energy, and waste disposal.
4. Download videos on frit making and enameling process in industries and prepare a brief report.

c. Other Activities:

1. Seminar Topics:

- Commercially available enamel raw materials in India.
- Major application areas of enamel.
- Enamel defects and prevention strategies.
- Advancement in enamel formulations.
- Innovative enamel application techniques.

2. Visits:
Visit nearby enameling industries. Prepare report of visit with special comments of material used for enamel making, process applied, major application area, major consumer, costing.

3. Self-Learning Topics:

- Smelter for frit making.
- Ground coat enamel.
- Cover coat enamel.
- Presence of enamel raw material in India

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

Legend:
*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
#: Mentioned under point-(O)

Note:

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

N) Suggested Specification Table for End Semester Theory Assessment:

Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Raw Materials for Enamel	06	CO1	7	4	3	-
Unit-2.0 Preparation of Metal Surfaces for Enameling	12	CO2	18	5	8	5
Unit-3.0 Frit, Milling, Mill Addition, and Enamel Properties	09	CO3	13	4	5	4
Unit-4.0 Enamel Composition, Application of Enamel, Drying, Firing, Dryer, and Furnaces	12	CO4	18	5	8	5
Unit-5.0 Enamel Defects and Modern Developments in Enamel	09	CO5	14	2	5	7
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):

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Preparing steel plate surface for enameling by pickling process.	CO1, CO2	30	60	10
2.	Preparing cast iron plate surface for enameling by pickling process.	CO1, CO2	30	60	10
3.	Prepare aluminum plate surface for enameling by pickling process.	CO1, CO2	30	60	10
4.	Preparation of a batch of frit mixture for ground coat enamel.	CO1, CO2	30	60	10
5.	Preparation of a batch of frit mixture for cover coat enamel.	CO1, CO3	30	60	10
6.	Preparation of a frit batch of cover coat green and blue color Enamel.	CO1, CO3	30	60	10
7.	Performing enameling on a substrate and drying and firing.	CO3, CO4	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.	Electronic weighing balance	10 kg weighing capacity,	4,5,6
2.	Refractory Crucible	Max Temperature 0-1000 degree Celsius	4,5,6
3.	Mortar & Pestle	6'' and 8'' diameter	4,5,6
4.	Electric Furnace (1500°C)	Laboratory Type, Working Temperature 1400 ºC - 1500 ºC, Thermocouple PtRh%10-Pt, Door Opening to right or left Insulation Material, Refractory brick + Ceramic Blanket, Power Controller -SSR	4,5,6,7
6.	Jaw Crusher	Laboratory Type, High crushing efficiency, feed sizes up to 40 mm can be crushed to 0.5 mm, Removable jaw for easy cleaning, Adjustable speed, Wear compensation with zero-point adjustment, Convenient operating keypad with digital display, Memory for gap width setting. Capacity- 100-200 kg/hours, 440 volts, 3 phase	4,5,6
7.	Ball Mill	Laboratory Type, Max. speed 650 rpm Up to 10 mm feed size and 0.1 µm final fineness 1 grinding station for jars from 12 ml up to 500 ml Jars of 12 – 80 ml can be stacked (two jars each) Grind Control to measure temperature and pressure inside the jar. Aeriation lids to control the atmosphere inside the jar. Storable SOPs and cycle programs, 5 different jar materials for dry and wet grinding Capacity- 5 to 10 kg, Rotation speed- 30-80 rpm,2 HP, 220 volt	4,5,6

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Ceramic Materials Formation	R. P. Sinha	Novelty; 2nd Edition, ASIN: B083W91KDL
2.	Refractory Technology Fundamentals and Applications	Ritwik Sarkar	Publisher: 1s CRC Press; st edition ISBN-10: 0367574292
3.	Industrial Ceramics	F. Singer and S.S. Singer	Publisher: Springer ISBN-10: 9401752591
4.	Handbook of glass technology	Dr. R. Chavan	Publisher: WileyAmerican Ceramic Societ- ISBN-10: 1119219868
5.	Refractories	F. H. Norton	Publisher : McGraw-Hill ISBN-10 : 0070475385
6.	Refractories Production and Properties	J. H. Chesters	Publisher: W.P. : ISBN-10:1845691202

(b) Online Educational Resources:

1. https://en.wikipedia.org/wiki/Industrial_porcelain_enamel
2. https://en.wikipedia.org/wiki/Industrial_porcelain_enamel#Frit
3. https://en.wikipedia.org/wiki/Industrial_porcelain_enamel#Application
4. https://ceramics.onlinelibrary.wiley.com/doi/abs/10.1111/j.1151-2916.1926.tb17958.x
5. https://ganeshmrgn.wordpress.com/2017/03/31/pickling-vs-enameling/

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

******

A) Course Code : **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 suitableuse 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 excellentand 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 classesin 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 SpecificOutcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** EngineeringTools	**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

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.

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	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2418305	Python programming	30	70	20	30	20	30	200

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:

- Separate passing is must for progressive and end semester assessment for both theory and practical.
- 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: T 2418305

<table>
<tr><th>Major Theory Session Outcomes (TSOs)</th><th>Units</th><th>Relevant COs Number(s)</th></tr>
<tr><td>TSO 1a. Differentiate between Procedure Oriented P and Object Oriented Programming approach with example.
TSO 1b. Use the concept of Lvalue and Rvalue
TSO 1c. Write python program using various data types and operators</td><td>Unit 1: Fundamentals of Python Programming Syntax

1.1 Introduction to Python Character Set, Python Tokens, Variables, Lvalue and Rvalue Concepts, and the Use of Comments.

1.2Overview of Data Types:
• 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
1.3 Understanding Operators:
• 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</td><td>CO-1</td></tr>
<tr><td>TSO 2a. Write Python program using decision making statements
TSO 2b. Write Python program using loop structure to solve iterative problems</td><td>Unit-2.0 Conditional and Iterative statements
2.1 Conditional statements:
• simple if statement
• if- else statemen
• if-elif-else statement
2.2 Iterative statements:
• while loop
• for loop
• range function
• break and continue statements
• nested loops</td><td>CO-2</td></tr>
<tr><td>TSO 3a. Perform various operations on string using string operators and methods
TSO 3b. Perform various operations on List using list operators and methods</td><td>Unit-3.0 String, List, Tuples, set and Dictionary
3.1 String:
• Indexing</td><td>CO-3</td></tr>
</table>

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3c. Perform various operations on tuples using tuples operators and methods *TSO 3d.* Perform various operations on set using set methods *TSO 3e.* Perform various operations on dictionary using dictionary methods	• string operations (concatenation, repetition, membership & slicing) • traversing a string using loops • built-in functions. 3.2 Lists: • 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 3.3 Tuples: Creating, initializing, accessing elements, tuple assignment, performing operations on tuples, tuple methods and built-in functions, nested tuples 3.4 Set: Creating set, traversing, adding, removing data in set, performing set operations like join, Union intersection, difference 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.	
TSO 4a. Create and use user defined functions to implement modular programming approach *TSO 4b.* Differentiate variable scope with example. *TSO 4c.* Import and use Python modules, libraries	**Unit-4.0 Python Functions, Modules and packages** 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 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	**CO-4**
TSO 5a. Write simple Python programs using numpy *TSO 5b.* Use Numpy array in python program *TSO 5c.* Use Numpy to solve linear algebra problem.	**Unit-5.0 Numpy** 5.1 Introduction to NumPy 5.2 Installation of NumPy 5.3 NumPy Arrays: • Understanding the NumPy array • The fundamental data structure in NumPy. • Creation of arrays using different methods: np.array(), np.zeros(), no one's (), etc. • Exploring array attributes like shape, size, and dimensions. 5.4 Array Indexing and Slicing:	**CO-5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	• Accessing elements and subarrays in NumPy arrays using indexing and slicing. • Demonstration of the difference between one-dimensional and multi-dimensional array indexing. 5.5 Array Operations: • Performing element-wise operations on NumPy arrays. • Exploring universal functions (ufuncs) for mathematical operations. 5.6 Linear Algebra with NumPy: • Introduction to linear algebra operations using NumPy. • Matrix multiplication, determinant, inverse, and solving linear equations. 5.7 File input and output with Numpy 5.8 Broadcasting in Numpy	
TSO 6a. Explain different types of Exceptions in python *TSO 6b.* Write Python programs for exception handling in Python *TSO 6c.* Differentiate different modes of file opening. *TSO 6d.* Perform read, Write, Append operations in files	**Unit 6: Exception and File Handling in Python** 6.1 Exception Handling: syntax errors, exceptions, need of exception handling, user-defined exceptions, raising exceptions, handling exceptions, catching exceptions, Try - except - else clause, Try - finally clause, recovering and continuing with finally, built-in exception classes. 6.2 File Handling: text file and binary file, file types, open and close files, reading and writing text files, reading and writing binary files, file access modes	**CO-6**

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

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

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Write, execute and debug simple Python program using Integrated Development and Learning Environment (IDLE) *LSO 1.2.* Write and execute simple 'C' program using variables, arithmetic expressions.	1.	a) Download and Install IDLE. Write and execute Python program to- b) Calculate the Area of a Triangle where its three sides a, b, c are given. s=(a+b+c)/2, Area=square root of s(s-a)(s-b)(s-c) (write program without using function) c) Swap Two Variables d) Solve quadratic equation for real numbers.	**CO-1**
LSO 2.1. Write and execute python programs using conditional statements.	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)
LSO 2.2. 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.	
LSO 3.1. 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**
LSO 4.1. 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**
LSO 5.1. 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**
LSO 6.1. 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**
LSO 7.1. 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)
LSO 8.1. 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**
LSO 10.1. Write and execute Python program to define a numpy array. *LSO 10.2.* 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**
LSO 11.1. Develop and execute Python program to handle various type of exceptions. *LSO 11.2.* 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. Crete 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 in to a number by adding all the individual alphabet 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:
1. Tkinter widgets in python
2. Python date/time module and its applications
3. wxPython and its applications

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	15%	16%	16%	10%	16%
CO-2	15%	15%	15%	16%	16%	15%	16%
CO-3	25%	25%	20%	18%	18%	25%	18%
CO-4	15%	15%	15%	16%	16%	15%	16%
CO-5	25%	25%	25%	18%	18%	25%	18%
CO-6	10%	10%	10%	16%	16%	10%	16%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)

Unit-1.0 Basics of Python Programming syntax	4	CO-1	7	3	2	2
Unit-2.0 Conditional and Iterative statements	6	CO-2	10	3	3	4
Unit-3.0 3.0 String, List, Tuples, set and Dictionary	12	CO-3	18	5	3	10
Unit-4.0 Python Functions, Modules and packages	7	CO-4	10	3	3	4
Unit-5.0 Numpy	12	CO-5	18	4	5	9
Unit-6.0 Exception and File Handling in Python	7	CO-6	7	2	2	3
Total	**48**	**-**	**70**	**20**	**18**	**32**

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

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Write and execute Python program to- a) Calculate the Area of a Triangle where its three sides a,b,c are given. s=(a+b+c)/2, Area=square root of s(s-a)(s-b)(s-c) (write program without using function) b) Swap Two Variables c) Solve quadratic equation for real numbers.	**CO-1**	40	50	10
2.	Write and execute Python program to- a) Check if a Number is Positive, Negative or zero. b) Check whether the given year is a Leap Year. c) Print all Prime Numbers in an Interval. d) Display the multiplication Table based on the given input. e) Print the Fibonacci sequence. f) Find the Factorial of a Number.	**CO-2**	40	50	10
3.	Write and execute Python program to- a) Check whether the string is Palindrome b) Reverse words in a given String in Python c) identify in a strings the name, position and counting of vowels. d) Count the Number of matching characters in a pair of string (set) e) Python program for removing i-th character from a string	**CO-2, CO3**	40	50	10
4.	Write and execute Python program to- a) find largest number in a given list without using max(). b) find the common numbers from two lists. c) create a list of even numbers and another list of odd numbers from a given list. d) To find number of occurrences of given number without using built-in methods.	**CO-2, CO-3**	40	50	10
5.	Write and execute Python program to- a) find the index of an item of a tuple.	**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 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')]				
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
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

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
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.1st 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, 2nd 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 recourses before use by the students.

******

A) Course Code : **2413306(P2413306/S2413306)**

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				
2413306	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)	
2413306	Summer Internship -I	-	-	10	15	10	15	50

Legend:

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

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

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

Note:

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

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

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

J) Assessment of Summer Internship -I

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

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

******