

**Curriculum of Diploma Programme**  
**in**  
**Fire Technology & Safety**



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

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

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### 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				
2448301	PCC	Fire Codes, Standards and Legal Aspects	02	01	-	02	05	04
2448302	PCC	Engg. Materials	03	-	04	02	09	06
2448303	PCC	Thermal Engg.	03	-	04	02	09	06
2448304	PCC	Fundamental of Electrical & Mechanical Measurements	03	-	04	02	09	06
2448305	PCC	Explosions and Industrial Fire Safety	02	01	-	02	05	04
2400007	NRC	Indian Constitution (Common for All Programmes)	01	-	-	-	01	01
2448306	PSI	Summer Internship – I (After 2 <sup>nd</sup> Sem) (Common for all programmes)	-	-	02	02	04	02
2452107	NRC	Basics of Liberal Art (FTS, GT, TE, MIE)	01	-	-	-	01	01
<b>Total</b>			<b>15</b>	<b>2</b>	<b>14</b>	<b>12</b>	<b>43</b>	<b>30</b>

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

**Legend:**

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

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

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

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

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

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

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

### Semester - 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)	
2448301	PCC	Fire Codes, Standards and Legal Aspects	30	70	20	30	-	-	150
2448302	PCC	Engg. Materials	30	70	20	30	20	30	200
2448303	PCC	Thermal Engg.	30	70	20	30	20	30	200
2448304	PCC	Fundamental of Electrical & Mechanical Measurements	30	70	20	30	20	30	200
2448305	PCC	Explosions and Industrial Fire Safety	30	70	20	30	-	-	150
2448306	PSI	Summer Internship – I (After 2 <sup>nd</sup> Sem) (Common for all programmes)	-	-	10	15	10	15	50
2400007	NRC	Indian Constitution (Common for All Programmes)	25	-	-	-	-	-	25
2452107	NRC	Basics of Liberal Art (FTS, GT, TE, MIE)	25	-	-	-	-	-	25
<b>Total</b>			<b>200</b>	<b>350</b>	<b>110</b>	<b>165</b>	<b>70</b>	<b>105</b>	<b>1000</b>

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

**Legend:**

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

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

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

**Note:**

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

- A) **Course Code** : 2448301(T2448301/S2448301)  
 B) **Course Title** : Fire Codes and Standards and Legal Aspects  
 C) **Pre- requisite Course(s)** :  
 D) **Rationale** :

Destruction can result from fires. Flames and smoke from a fire can spread swiftly, seriously harming both people and property. With the goal to establish a common understanding in the areas of Fire Prevention, Life safety and Fire Protection —which involve the design, installation, operations, and procedures whether related to equipment, activities, or any kind of system which pose a fire hazard—Fire Standards and Codes are documents that serve as safety guidelines to individuals, organizations, and statutory bodies.

This course aims to acquaint students with systems for fire safety and codes relevant to them and incorporate.

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

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

- CO-1** Explain the codes and standards applicable to ensure safety against fire destructions  
**CO-2** Use legislations/laws applicable to fire prevention and protection  
**CO-3** Ensure standards in procurement and use of tools and equipment  
**CO-4** Explain provisions related to fire prevention and protection in fire service act and rules  
**CO-5** Ensure to implement Legal aspects on Fire safety at work place and establishments

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

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

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

## G) Teaching &amp; 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				
2448301	Fire Codes and Standards and Legal Aspects	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)

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

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

## H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2448301	Fire Codes and Standards and Legal Aspects	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: T2448301**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Use code and standards of buildings to ensure minimal fire distraction</p> <p><i>TSO 1b.</i> Explain national code applicable to fire prevention</p> <p><i>TSO 1c.</i> Ensure provisions of code of practice save life against fire breakout</p> <p><i>TSO 1d.</i> Carryout fire dill practice as per standards laid down in NBC</p>	<p><b>Unit-1.0 Code and Standards Concerning Construction &amp; Design of Building</b></p> <p>1.1 National Building Code (NBC 2016)</p> <p>1.2 Fire prevention code provisions</p> <p>1.3 Fire protection &amp; lifesaving code provisions</p> <p>1.4 Guideline for fire drill and evacuation process</p>	<b>CO1</b>
<p><i>TSO 2a.</i> Ensure all possible codes applicable to buildings</p> <p><i>TSO 2b.</i> Follow the Byelaws of Industries for fire protection</p> <p><i>TSO 2c.</i> Ensure road and street byelaws with respect to fire fighting</p>	<p><b>Unit-2.0 Code, Standard and Byelaws</b></p> <p>2.1 Byelaws of local municipal for buildings</p> <p>2.2 Byelaws of Industries for fire protection</p> <p>2.3 Byelaws of Roads and streets</p>	<b>CO2</b>
<p><i>TSO 3a.</i> Follow Indian standards of equipment while procuring</p> <p><i>TSO 3b.</i> Use standard quality helmet while fighting at fire risk</p> <p><i>TSO 3c.</i> Ensure quality and standard material PPE kit</p> <p><i>TSO 3d.</i> Ensure proper piping configuration for safety requirement against fire</p>	<p><b>Unit-3.0 Safety Norms of Firefighting Personnel</b></p> <p>3.1 Indian standards for fire saving equipments.</p> <p>3.2 Metal and non-metal helmet standards</p> <p>3.3 Standards for PPE of firefighters</p> <p>3.4 SOP for firefighting personnel</p>	<b>CO3</b>
<p><i>TSO 4a.</i> Ensure local byelaws of buildings</p> <p><i>TSO 4b.</i> Implement byelaws as per provisions in the fire code</p> <p><i>TSO 4c.</i> Follow standards of scaffoldings for High-rise building</p>	<p><b>Unit-4.0 Code and Practice for Construction and Temporary Structures</b></p> <p>4.1 Byelaws and provision of Tent house structure</p> <p>4.2 Byelaws and provision of Social gathering functions</p> <p>4.3 Norms of scaffolding for high rise structure</p>	<b>CO4</b>
<p><i>TSO 5a.</i> Implement fire related legislation at site</p> <p><i>TSO 5b.</i> Follow fire safety rules applicable to various type of industry and products</p> <p><i>TSO 5c.</i> Implement Electricity act effectively</p> <p><i>TSO 5d.</i> Work as per legal aspect of disaster management</p>	<p><b>Unit-5.0 Legal Aspects on Fire Safety</b></p> <p>5.1 Fire safety legislation</p> <p>5.2 Fire safety acts of Industries- Petroleum Rules, Gas Cylinder Rules, Explosive Rules, and Factories.</p> <p>5.3 Indian Electricity Act for fire protection</p> <p>5.4 Disaster Management legislation</p>	<b>Environmental Protection Act</b>

**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: S2448301** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

**a. Assignments:**

1. Collect international standards used for fire suppression systems and Material used

**b. Micro Projects:**

- Visit the smart city office and develop a report on use of codes and standard applicable for fire safety

**c. Other Activities:**

1. Seminar Topics:

- Fire code in developed countries
- Problems in implementing fire standard at ground

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

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

**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 Code and Standards Concerning Construction & Design of Building	10	CO1	10	3	3	4
Unit-2.0 Code, Standard and Byelaws	8	CO2	15	5	4	6
Unit-3.0 Safety Norms of Firefighting Personnel	10	CO3	10	4	2	4
Unit-4.0 Code and Practice for Construction and Temporary Structures	10	CO4	20	4	6	10
Unit-5.0 Legal Aspects on Fire Safety	10	CO5	15	4	6	5
<b>Total</b>	<b>48</b>	<b>-</b>	<b>70</b>	<b>20</b>	<b>21</b>	<b>29</b>

**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.	Fire Audit in Building	Dr. Gopal Chandra Mishra,	PPA Publications Lucknow 2021
2.	Indian Standard Code of Practice for Fire Safety of Building (General) General Principles of Fire Grading and Classification IS 1641-1988	Bureau of Indian Standards	Edition: Fourth Reprint Year of Publication: 2007
3.	Indian Standard Code of Practice for Fire Safety of Buildings (General) Exposure Hazard IS 1643-1988	Bureau of Indian Standards	Edition: Second Reprint Year of Publication: 2007
4.	Indian Standard Fire Safety of Buildings (General) Exit Requirements and Personal Hazard Code of Practice IS 1644:2013	Bureau of Indian Standards	Edition: Second Year of Publication: 2013
5	Indian Standard Fire Safety of Buildings (General) Details of Construction Code of Practice IS 1642:2013	Bureau of Indian Standards	<b>Edition:</b> Second Revised <b>Year Of Publication:</b> 2013
6	Indian Standard Code of Practice for Fire Safety of Building (General) Electrical Installations IS 1646 1997	Bureau of Indian Standards	<b>Edition:</b> Second Revised <b>Year Of Publication:</b> 2002

**(b) Online Educational Resources:****1-National Building Code of India 2016 (NBC 2016), Bureau of Indian Standards**

- URL: <https://www.bis.gov.in/standards/technical-department/national-building-code/>

**2- Fire safety technologies, Volume 23, Issue 06**

- URL: [https://www.drdo.gov.in/sites/default/files/technology-focus-document/TF\\_December\\_2015\\_WEB.pdf](https://www.drdo.gov.in/sites/default/files/technology-focus-document/TF_December_2015_WEB.pdf)

**3- Handbook on building fire code**

- URL: <https://www.iitk.ac.in/nicee/IITK-GSDMA/F05.pdf>

**4- Indian Standard on Fire Safety Equipments**

- URL: <https://dgfscdhg.gov.in/sites/default/files/INDIAN%20STANDARD%20ON%20FIRE%20SAFETY%20EQUIPMENTS.pdf>

**5- The Factories Act, 1948**

- URL: [https://labour.gov.in/sites/default/files/factories\\_act\\_1948.pdf](https://labour.gov.in/sites/default/files/factories_act_1948.pdf)

**6- Gujarat-Fire-Service-Act**

- URL: <https://www.ifeindia.org/writereaddata/Gujarat-Fire-Service-Act.pdf>

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

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- A) **Course Code** : 2448302(T2448302/P2448302/S2448302)  
 B) **Course Title** : Engineering Materials  
 C) **Pre- requisite Course(s)** :  
 D) **Rationale** :

Materials Engineering is a critical discipline that plays a vital role in the development and advancement of various Engineering fields by making the engineers understand the properties and behavior of materials that enables them to design and build structures, devices and systems that are efficient, safe and reliable. The course helps to learn the fundamental properties of materials, including mechanical, electrical, thermal and chemical properties that help to characterize and evaluate these properties to select appropriate materials for specific engineering applications. This also focuses on optimizing and minimizing the cost while maintaining or improving material performance. Thus, this learning helps the learner to gain knowledge in an aspect that can further contribute to enhance the material property, advancing scientific knowledge, improving safety and reliability, enabling technological advancements and better environmental impacts through available engineering materials.

- 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** Classify basic structure of engineering materials and apply in practice  
**CO-2** Explain various physical and mechanical properties of engineering materials in application  
**CO-3** Elaborate the equilibrium & phase diagram of iron and alloy materials for their application  
**CO-4** Describe the applications of various Electrical and Magnetic materials used in engineering applications  
**CO-5** Explain corrosion, types, causes and protection, Select relevant materials for engineering applications.

**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 & Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2
CO-1	3	3	3	2	3	1	1	-	-
CO-2	3	3	3	2	2	-	2	-	-
CO-3	3	3	2	-	1	-	1	-	-
CO-4	3	2	3	1	1	1	3	-	-
CO-5	3	3	3	-	3	1	3	-	-

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

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## G) Teaching &amp; 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				
2448302	Engineering Materials	03	-	04	02	09	06

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## 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)	
2448302	Engineering Materials	30	70	20	30	20	30	200

## Legend:

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## J) Theory Session Outcomes (TSOs) and Units: T2448302

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain classification of engineering materials and structure- property relationship</p> <p><i>TSO 1b.</i> Differentiate crystalline and non-crystalline materials and explain Miller Indices</p> <p><i>TSO 1c.</i> Describe crystal planes &amp; directions and examine crystal structure using X – rays.</p> <p><i>TSO 1d.</i> Explain Inorganic solids, Silicate structures and their application</p> <p><i>TSO 1e.</i> Explain various defects, point, line and surface defects</p>	<p><b>Unit-1.0 Structure of Solids</b></p> <p>1.1 Classification of engineering materials and structure - property relationship</p> <p>1.2 Crystalline and non-crystalline materials, Miller Indices</p> <p>1.3 Crystal planes &amp; directions, determination of crystal structure using X-rays</p> <p>1.4 Inorganic solids, Silicate structures and their applications</p> <p>1.5 Defects; Point, line and surface defects</p>	<b>CO1</b>
<p><i>TSO 2a.</i> Explain elastic, an-elastic and viscoelastic behavior of engineering materials</p> <p><i>TSO 2b.</i> Describe the basic stress - strain and true stress - strain relationship</p> <p><i>TSO 2c.</i> Explain mechanical properties and Plastic deformation by twinning and slip</p> <p><i>TSO 2d.</i> Describe the basics of movement of dislocations &amp; define critical shear stress</p> <p><i>TSO 2e.</i> Explain the basics of Strengthening mechanism and define Creep</p>	<p><b>Unit-2.0 Mechanical Properties of Materials</b></p> <p>2.1 Elastic, Anelastic and Viscoelastic behavior of engineering materials</p> <p>2.2 Stress and strain relationship, True stress - true strain relationship</p> <p>2.3 Study of mechanical properties and Plastic deformation by twinning and slip</p> <p>2.4 Movement of dislocations &amp; Critical shear stress</p> <p>2.5 Strengthening mechanism and Creep</p>	<b>CO2</b>
<p><i>TSO 3a.</i> Explain basics of various Solids solutions and alloys</p> <p><i>TSO 3b.</i> Define Gibbs phase rule &amp; explain its use</p> <p><i>TSO 3c.</i> Elaborate the Unary and binary eutectic phase Diagram</p> <p><i>TSO 3d.</i> Explain applications of phase diagrams thru examples</p> <p><i>TSO 3e.</i> Describes basics of Iron-Iron carbide equilibrium and phase diagram phase diagram</p>	<p><b>Unit-3.0 Equilibrium Diagram</b></p> <p>3.1 Solids solutions and alloys</p> <p>3.2 Gibbs phase rule</p> <p>3.3 Unary and binary eutectic phase Diagram</p> <p>3.4 Examples and applications of phase diagrams</p> <p>3.5 Iron-Iron carbide equilibrium and phase diagram</p>	<b>CO3</b>
<p><i>TSO 4a.</i> Select right conducting and resisting materials for engineering applications</p> <p><i>TSO 4b.</i> Define properties of semiconducting materials and select appropriate material for given application</p> <p><i>TSO 4c.</i> Define properties of magnetic materials and select appropriate material for given application</p> <p><i>TSO 4d.</i> Define properties and applications of Superconductors and Dielectric materials</p> <p><i>TSO 4e.</i> Describe piezoelectric, magneto-strictive and electro-strictive materials, sensors and actuators and their applications</p>	<p><b>Unit-4.0 Electrical and Magnetic Materials</b></p> <p>4.1 Study of conducting and resisting materials and their engineering application</p> <p>4.2 Properties and application of Semiconducting materials</p> <p>4.3 Properties, types and applications of Magnetic materials</p> <p>4.4 Properties and applications of Superconductors &amp; Dielectric materials</p> <p>4.5 <u>Study of Smart materials</u>: Sensors and actuators, piezoelectric, magneto-strictive and electro-strictive materials</p>	<b>CO4</b>

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 5a.</i> Describe corrosion, its types and causes</p> <p><i>TSO 5b.</i> Apply protection against corrosion in practice</p> <p><i>TSO 5c.</i> Remember various important properties of engineering materials</p> <p><i>TSO 5d.</i> Select appropriate engineering materials for various applications</p>	<p><b>Unit-5.0 Corrosion process and Materials Selection</b></p> <p>5.1 Study of Corrosion, Cause and Types</p> <p>5.2 Protection against corrosion</p> <p>5.3 Overview of properties of engineering materials</p> <p>5.4 <b>Selection</b> of materials for different engineering applications</p>	CO5

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

### K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2448302

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<p><i>LSO 1.1</i> Prepare a specimen as per given dimensions for Tensile Testing.</p> <p><i>LSO 1.2</i> Setup Universal Testing Machine for the experiment.</p> <p><i>LSO 1.3</i> Measure and Calculate Young's modulus, upper &amp; lower yield stress and toughness of the given material</p>	1	Determination of the Young's modulus, upper and lower yield stress and toughness of the given material	CO2
<p><i>LSO 2.1</i> Prepare a specimen as per given dimensions for shear stress.</p> <p><i>LSO 2.2</i> Setup Impact Testing Machine for Shear Stress Testing</p> <p><i>LSO 2.3</i> Measure and Calculate rigidity modulus and maximum shear stress for the given material</p>	2	Determination the rigidity modulus and maximum shear stress for the given material.	CO2
<p><i>LSO 3.1</i> Prepare specimens for Hardness Testing.</p> <p><i>LSO 3.2</i> Setup Various Hardness Testing Machines for the measurement</p> <p><i>LSO 3.3</i> Measure and evaluate hardness as per Hardness Chart for the given material</p>	3	find the hardness of given material by using Rockwell hardness tester, Brinell and Vickers hardness testing machines	CO2
<p><i>LSO 4.1</i> Prepare a specimen as per given dimensions for Deflection Testing.</p> <p><i>LSO 4.2</i> Setup Universal Testing Machine for Deflection Testing</p> <p><i>LSO 4.3</i> Measure and Calculate deflection in beams of different materials of the given material</p>	4	Compute the various (both theoretical and practical values) of the deflection in beams of different materials.	CO2
<p><i>LSO 5.1</i> Cutting of a specimen using Parting Machine</p> <p><i>LSO 5.2</i> Grind the cut specimen using Grinding machine</p> <p><i>LSO 5.3</i> Setup Polishing machine and polish the specimen using various polishing papers to prepare the specimen for Micro-Structure Examination</p>	5	preparation of te Specimen for micro structural examination – cutting, grinding, polishing, etching	CO1
<p><i>LSO 6.1.</i> Setup Microscope for study of Crystal Structure</p> <p><i>LSO 6.2.</i> Study and prepare report of Crystal Structures of the given specimen</p>	6	Observe the Crystal Structures of a given specimen.	CO1
<p><i>LSO 7.1.</i> Prepare experimental setup for Measurement of Hall Coefficient of a Semiconductor</p>	7	Determination of Hall Coefficient of a Semiconductor	CO4

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 7.2.</i> Measure and Calculate Hall Coefficient of a of the given Semiconductor			
<i>LSO 8.1.</i> Prepare experimental setup for study of Energy loss of a Magnetic material <i>LSO 8.2.</i> Measure, Calculate and Plot Energy loss of a Magnetic material	8	Measurement Energy loss of a Magnetic material	CO4
<i>LSO 9.1.</i> Prepare experimental setup for Energy band gap of a semiconducting diode <i>LSO 9.2.</i> Measure and Calculate Energy band gap of a semiconducting diode	9	Assessment of Energy band gap of a semiconducting diode	CO4
<i>LSO 10.1</i> Prepare experimental setup for study mechanism of chemical corrosion and its protection. <i>LSO 10.2</i> Observe and evaluate extent of corrosion and its protection	10	Analysis of the mechanism of chemical corrosion and its protection.	CO5

L) **Suggested Term Work and Self Learning: S2448302** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. **Assignments:**

1. Collect information on recent Advancements in Engineering Materials.

b. **Micro Projects: NOT APPLICABLE**

c. **Other Activities:**

1. Seminar Topics:
  - Upcoming Advancements in Material Science
  - Advanced Metal Composites and their 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	20%	20%	20%	-	20%	20%	20%
CO-2	30%	30%	20%	-	20%	40%	40%
CO-3	20%	20%	20%	-	20%	--	--
CO-4	15%	15%	20%	-	20%	30%	30%
CO-5	15%	15%	20%	-	20%	10%	10%
<b>Total Marks</b>	<b>30</b>	<b>70</b>	<b>30</b>	<b>-</b>	<b>20</b>	<b>20</b>	<b>30</b>
			<b>50</b>				

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 is 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 for progressive assessment.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
<b>Unit-1.0:</b> Structure of Solids	8	CO1	15	4	6	5
<b>Unit-2.0:</b> Mechanical Properties of Materials	12	CO2	20	6	6	8
<b>Unit-3.0:</b> Equilibrium Diagram	10	CO3	15	4	6	5
<b>Unit-4.0:</b> Electrical and magnetic Materials	10	CO4	10	3	3	4
<b>Unit-5.0</b> Corrosion Process and Materials Selection	08	CO5	10	3	3	4
<b>Total</b>	<b>48</b>	<b>-</b>	<b>70</b>	<b>20</b>	<b>24</b>	<b>26</b>

**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.	Determination of the Young's modulus, upper and lower yield stress and toughness of the given material	CO2	45	45	10
2.	Determination the rigidity modulus and maximum shear stress for the given material.	CO2	45	45	10
3.	find the hardness of given material by using Rockwell hardness tester, Brinell and Vickers hardness testing machines	CO2	45	45	10
4.	Compute the various (both theoretical and practical values) of the deflection in beams of different materials.	CO2	45	45	10
5.	preparation of the Specimen for micro structural examination – cutting, grinding, polishing, etching	CO1	45	45	10
6.	Observe the Crystal Structures of a given specimen.	CO1	45	45	10
7.	Determination of Hall Coefficient of a Semiconductor	CO4	45	45	10
8.	Measurement Energy loss of a Magnetic material	CO4	45	45	10
9.	Assessment of Energy band gap of a semiconducting diode	CO4	45	45	10
10.	Analysis of the mechanism of chemical corrosion and its protection.	CO5	45	45	10

To study the Erichsen sheet metal testing machine & perform the Erichsen sheet metal test 2. Preparation of specimen for Metallographic examination and Metallographic study of given specimen through metallurgical microscope. 3. To study hardness as a function of quench rate and investigate the hardenability of steels by Jominy End Quench Apparatus. 4. To gain experience with and understanding of the types, advantages and applications of various NDT methods. To be able to choose the best NDT method for a given part and perform Test on UFD machine. 5. To determine carbon and sulphur contents in iron and steel by Strohlein's Apparatus. 6. Study of Annealing process of heat treatment and its effect on microstructure and Mechanical Properties.

**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.	Universal Testing Machine & Extensometer	As per Proprietary Specifications	1
2.	Torsion Testing Machine and Vernier Caliper	As per Proprietary Specifications	2
3.	Impact Tester	As per Proprietary Specifications	3
4.	Brinell Hardness Testing Machine	As per Proprietary Specifications	4
5.	Vickers Hardness Testing Machine	As per Proprietary Specifications	5
6.	Rock Well Hardness Testing Machine	As per Proprietary Specifications	6
7.	Materials Microscope	As per Proprietary Specifications	7
8.	Power Supply for the electromagnet	0 – 16 Volts, 5 Amps	8
9.	Constant Current Power Supply	0 – 50 mA, Ideally 0 – 20 mA	9
10.	Gauss meter with Hall Probe	As per Proprietary Specifications	10
11.	Semiconducting sample	Ge single crystal) mounted on PCB. (p-type/n-type Ge crystal	10

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

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Materials Science and Engineering	W.D. Callister David G. Rethwisch	Publisher :Wiley ISBN-10: 1118476549 ISBN-13: 978-1118476543
2	Principles of Materials Science and Engineering	William F. Smith	Publisher : Mc-Graw Hills Education ISBN-10: 0071147179 ISBN-13: 978-0071147170
3	Introduction to Materials Science and Engineering	V. Raghavan	Publisher : Prentice Hall India Learning, ISBN-10: 9788120350922 ISBN-13: 978-81020350922
4	Engineering Material	R.K. Rajput	Publisher :S Chand and Company ISBN-10: 8121919606 ISBN-13: 978-8121919609
5	Principles of Electronic Engineering Materials	S.O. Kasap	Tata Mc-Graw Hill, 2007
6	Elements of Material Science and Engineering	L.H. Van Vlack	Thomas Press, India, 1998
7	Engineering Materials - Properties and Selection	K.G. Budinski	Prentice Hall India, 1996

**(b) Online Educational Resources:**

- 1) <https://www.bing.com/videos/riverview/relatedvideo?q=Video+Lecturer+on+Mechanical+properties>
- 2) <https://www.bing.com/videos/riverview/relatedvideo?q=NEPTL+video+lectures+on+Equilibrium+diagram>
- 3) <https://www.bing.com/videos/riverview/relatedvideo?&q=NEPTL+video+lectures+on+iron+carbon+equilibrium+diagram>
- 4) <https://www.bing.com/videos/riverview/relatedvideo?q=NEPTL+video+lectures+on+Electrical+and+magnetic+materials>
- 5) <https://www.bing.com/videos/riverview/relatedvideo?q=NEPTL+video+lectures+on+Corrosion+process+and+Materials>
- 6) <https://www.bing.com/videos/riverview/relatedvideo?q=NEPTL+video+lectures+on+Electrical+and+magnetic+materials>
- 7) <https://www.bing.com/videos/riverview/relatedvideo?q=NEPTL+video+lectures+on+Corrosion+proces>

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

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- A) **Course Code** : 2448303(T2448303/P2448303/S2448303)  
 B) **Course Title** : Thermal Engineering  
 C) **Pre- requisite Course(s)** :  
 D) **Rationale** :

Thermal engineering is a specialized discipline of mechanical engineering that deals with the generation, transfer, and utilization of heat and energy. It provides a solid foundation in the fundamental principles of thermodynamics, heat transfer, energy efficiency, system design, thermal design and fluid mechanics to understand and analyze thermal systems. Since the energy can be transformed between two mediums or transferred into other forms of energy, a thermal engineer must have knowledge of thermodynamics and the process to convert generated energy from thermal sources into chemical, mechanical, or electrical energy. Thus, its study is important for efficient energy uses, design and optimization for various industries including power generation, manufacturing, transportation and HVAC and to make students to apply the knowledge to analyze and solve real world thermal engineering problems encountered in various industries.

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

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

- CO- 1** Elaborate basics of thermal engineering with focus on second law of thermodynamics and entropy  
**CO- 2** Explain energy and work potential and elaborate properties of gases and gas mixtures  
**CO- 3** Describe the basics of various Steam and Vapor Power Cycles  
**CO- 4** Explain compression process and elaborate working of single and multi-stage reciprocating compressors  
**CO- 5** Explain the basics of thermodynamics of fluid flow and explain various thermodynamic relations

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

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

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

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

## G) Teaching &amp; 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				
2448303	Thermal Engineering	03	-	04	02	09	06

## Legend:

CI: Class room 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= (1xCIhours) + (0.5xLIhours) + (0.5xNotionalhours)

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

## H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2448303	Thermal Engineering	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, and seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) **Course Curriculum Detailing:** 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: T2448303

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain Second law of Thermodynamics and concept of entropy</p> <p><i>TSO 1b.</i> Define Clausius' Theorem and Clausius' inequality and explain properties of entropy</p> <p><i>TSO 1c.</i> Describe entropy change in various processes, Entropy principle and application</p> <p><i>TSO 1d.</i> Explain entropy generation in a closed and open system</p> <p><i>TSO 1e.</i> Understand Entropy and Disorder</p>	<p><b>Unit-1.0 Analysis of Second Law of Thermodynamics</b></p> <p>1.1 Review of Second law of Thermodynamics and concept of entropy</p> <p>1.2 Clausius' Theorem and Clausius' inequality Properties of entropy</p> <p>1.3 Entropy change in various processes, Entropy Principle and its application</p> <p>1.4 Entropy generation in a closed and open system</p> <p>1.5 Entropy and Disorder</p>	<b>CO1</b>
<p><i>TSO 2a.</i> Explain Exergy and its connection with K.E. and P.E.</p> <p><i>TSO 2b.</i> Describe the Concept of reversible work and irreversibility</p> <p><i>TSO 2c.</i> Discuss the Avogadro's Law, Equation of State, Virial Expressions</p> <p><i>TSO 2d.</i> Explain Law of corresponding states and Properties of Mixtures of gases</p> <p><i>TSO 2e.</i> Elaborate the Concept of Internal Energy, enthalpy, specific heat and entropy of gas mixtures</p>	<p><b>Unit-2.0 Exergy, Properties of Gases &amp; Gas-Mixtures</b></p> <p>2.1 Exergy-work potential of energy associated with K.E. and P.E.</p> <p>2.2 Concept of reversible work and irreversibility, Second law of efficiency</p> <p>2.3 Avogadro's Law, Equation of State, Virial Expressions</p> <p>2.4 Law of corresponding states and Properties of Mixtures of gases</p> <p>2.5 Internal Energy, enthalpy, specific heat and entropy of gas mixtures</p>	<b>CO2</b>
<p><i>TSO 3a.</i> Explain properties and processes of ideal vapour, qualities of steam and elaborate simple steam power cycle</p> <p><i>TSO 3b.</i> Describe basic principles of Rankine Cycle, Reheat cycle &amp; Binary Vapour Cycles</p> <p><i>TSO 3c.</i> Elaborate Actual Vapour Cycle and its Processes</p> <p><i>TSO 3d.</i> Differentiate between Ideal and Practical Regenerative Cycles</p> <p><i>TSO 3e.</i> Remember Characteristics of an ideal Working Fluid in Vapour Power Cycles</p>	<p><b>Unit-3.0 Vapours and Vapour Power Cycles</b></p> <p>3.1 Properties and processes of ideal vapour, qualities of steam and Simple steam power cycle</p> <p>3.2 Rankine Cycle, Reheat cycle and Binary Vapour Cycles,</p> <p>3.3 Actual Vapour Cycle and its Processes</p> <p>3.4 Ideal and Practical Regenerative Cycles</p> <p>3.5 Characteristics of an ideal Working Fluid in Vapour Power Cycles</p>	<b>CO3</b>
<p><i>TSO 4a.</i> Classify Air Compressors and Enlist the Advantages and Disadvantages of Air compressors</p> <p><i>TSO 4b.</i> Explain various compression processes and elaborate working of Reciprocating Compression</p> <p><i>TSO 4c.</i> Elaborate the working of Single Stage Reciprocating Air Compressor</p> <p><i>TSO 4d.</i> Explain the working of Multi-Stage Compressor</p>	<p><b>Unit-4.0 Reciprocating Gas Compressor</b></p> <p>4.1 Classification of air compressors, Advantages and Disadvantages of Air compressors</p> <p>4.2 Compression Processes, Working of Reciprocating Compression</p> <p>4.3 Analysis of Single Stage Reciprocating Air Compressor</p> <p>4.4 Analysis of Multi-Stage Compressor</p>	<b>CO4</b>
<p><i>TSO 5a.</i> Elaborate Velocity of pressure pulse in a fluid and Stagnation Properties</p> <p><i>TSO 5b.</i> Explain one dimensional Steady Isentropic Flow, Choking in Isentropic Flow and enlist Critical Properties</p>	<p><b>Unit-5.0 Thermodynamics of Fluid Flow and Thermodynamics Relations</b></p> <p>5.1 Velocity of pressure pulse in a fluid and Stagnation Properties</p> <p>5.2 One dimensional Steady Isentropic Flow, Choking in Isentropic Flow, Critical Properties &amp;</p>	<b>CO5</b>

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 5c.</i> Explain Normal Shocks and differentiate between Adiabatic Flow with Friction and Diabatic Flow without Friction</p> <p><i>TSO 5d.</i> Explain the Joule-Kelvin Effect, Clausius-Clapeyron Equation and Evaluate Thermodynamic Properties from an Equation of State</p>	<p>5.3 Normal Shocks, Adiabatic Flow with Friction and Diabatic Flow without Friction</p> <p>5.4 Maxwell's Equations, Tds Equations, Energy Equation &amp; Relationship of heat capacities</p> <p>5.5 Joule-Kelvin Effect, Clausius-Clapeyron Equation &amp; Evaluation of Thermodynamic Properties from an Equation of State</p>	

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

### K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2448303

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 1.</i> Evaluate and classify Boiler Draught	1.	Study of Boiler Draught and their classification	CO1, CO3
<i>LSO 2.</i> Describe features and functions of Subcritical boiler	2.	Study of Subcritical boiler with demonstrate model.	CO1, CO3
<i>LSO 3.</i> Describe features and functions of Supercritical boiler	3.	Study of Supercritical boiler with demonstrate model.	CO1, CO3
<i>LSO 4.</i> Calculate Mechanical Equivalent of Heat through Joule's Experiments	4.	Verify Joule's Experiments on Mechanical Equivalent of Heat	CO2
<i>LSO 5.</i> Apply standard procedure to determine volumetric efficiency of a single acting, double stage reciprocating air compressor	5.	Determination of the Volumetric efficiency of a single acting, double stage reciprocating air compressor	CO4
<i>LSO 6.</i> Calculate airflow in duct and pipes.	6.	Determination of airflow in duct and pipes.	CO5
<i>LSO 7.</i> Solve numerical Problem Based on Steam Power Plant (Rankine Cycle)	7.	Numerical Problem Based on Steam Power Plant (Rankine Cycle)	CO3

L) **Suggested Term Work and Self Learning: S2448303** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

**a. Assignments:**

1. Prepare a Flow Chart for Classification of Air Compressors and Enlist the Advantages and Disadvantages of Air compressors.
2. Draw a sectional view of a Single Stage and Multi-Stage Reciprocating Air Compressor

**b. Micro Projects:**

- Visit a nearest site where Reciprocating Compressor is being used and prepare a report of the same

**c. Other Activities:**

1. Seminar Topics:

- Boiler Operations Training & Maintenance Seminar
- Servicing and Maintenance of Reciprocating Compressors

**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%	20%	-	20%	25%	25%
CO-2	20%	20%	20%	25%	20%	15%	15%
CO-3	30%	30%	20%	25%	20%	30%	30%
CO-4	20%	20%	20%	25%	20%	15%	15%
CO-5	15%	15%	20%	25%	20%	15%	15%
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 is 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 for **progressive assessment**.

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 Analysis of Second Law of Thermodynamics	08	CO1	10	2	4	4
Unit-2.0 Exergy, Properties of Gases & Gas-Mixtures	10	CO2	15	6	5	4
Unit-3.0 Vapours and Vapour Power Cycles	12	CO3	20	4	8	8
Unit-4.0 Reciprocating Gas Compressor	10	CO4	15	4	5	8
Unit-5.0 Thermodynamics of Fluid Flow and Thermodynamics Relations	08	CO5	10	4	3	5
<b>Total</b>	<b>48</b>	<b>-</b>	<b>70</b>	<b>20</b>	<b>23</b>	<b>27</b>

**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.	Study of Boiler draught and their classification	CO1, CO3	45	45	10
2.	Study of Subcritical boiler with demonstrate model.	CO1, CO3	45	45	10
3.	Study of Supercritical boiler with demonstrate model.	CO1, CO3	45	45	10
4.	Verify Joule's Experiments on Mechanical Equivalent of Heat	CO2	45	45	10
5.	To Determine the Volumetric efficiency of a single acting, double stage reciprocating air compressor	CO4	45	45	10
6.	Determination of airflow in duct and pipes.	CO5	45	45	10
7.	Numerical Problem Based on Steam Power Plant (Rankine Cycle)	CO3	45	45	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.	Subcritical Boiler Demonstrate Model	As per Proprietary Specifications	1
2.	Supercritical Boiler Demonstrate Model	As per Proprietary Specifications	2
3.	Single Acting, Double Stage Reciprocating Air Compressor	As per Proprietary Specifications	5

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

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Engineering Thermodynamics	P. K. Nag	Publisher: McGraw Hills Education ISBN-10: 9789352606429 ISBN-13: 978-9352606429
2.	Thermodynamics & Thermal Engineering	J. Selwin Rajadurai	Publisher: New Age International Pvt Ltd ISBN-10: 8122414931, ISBN-13: 978-8122414936
3.	Thermal Engineering	R. K. Rajput	Publisher: Laxmi Publications ISBN-10: 8131808041, ISBN-13: 978-8131808047
4.	A Textbook of Thermal Engineering	R. S. Khurmi & J. K Gupta	Publisher: S. Chand Publishing ISBN: 9355010540, 9789355010544
5	Thermodynamics: An Engineering Approach   9th Edition	Y. A. Cengel, Michael A. Boles, Mehmet Kanoglu	Publisher: McGraw Hill ISBN-13: 978-9353165741
6.	A Practical Guide to Compressor Technology	Heinz P. Bloch	Print ISBN: 9780471727934 Online ISBN:9780471929789 DOI:10.1002/0471929786

**(b) Online Educational Resources:**

1. <https://www.bing.com/videos/riverview/relatedvideo?q=Videos+Lecturers+on+Thermodynamics&mid>
2. [https://www.bing.com/videos/riverview/relatedvideo?q=Video%20Lecturer%20on%20Analysis%](https://www.bing.com/videos/riverview/relatedvideo?q=Video%20Lecturer%20on%20Analysis%20)
3. <https://www.youtube.com/watch?v=IYsXykd-Mdl>
4. <https://www.youtube.com/watch?v=IYsXykd-Mdl>
5. <https://www.youtube.com/watch?v=O2FwEIKg3ts>
6. <https://www.youtube.com/watch?v=ZVZYFqZUguY>

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

\*\*\*\*\*

- A) **Course Code** : 2448304(T2448304/P2448304/S2448304)  
 B) **Course Title** : Fundamental of Electrical and Mechanical Measurements  
 C) **Pre- requisite Course(s)** :  
 D) **Rationale** :

Electrical and mechanical measurements are important because they provide information about the electrical and mechanical properties of a system or circuit or site. This course aims to introduce student to understand how the different types of electrical and mechanical parameters work and to provide the knowledge of monitoring, analyzing and controlling of any electrical and mechanical system on site. The course provides some rudimentary understanding of the measuring instruments and demonstrates their correct and intelligent use. The student will acquire the basic knowledge about fundamental concepts and methods behind Electrical and mechanical measurements and will be thorough with principle of operation of basic measuring instruments and types of methods used for measurement various measuring techniques of electrical and mechanical terms.

- 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** Measure the electrical and mechanical parameters needed for various applications.  
**CO-2** Use electrical measuring equipment to measure the Current and Voltage  
**CO-3** Use mechanical devices such as transducers to measure the displacement and vibration  
**CO-4** Measure the flow of liquid and flow in a given situation  
**CO-5** Explain the electromechanical gages used for stress-strain measurement

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

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

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

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

## G) Teaching &amp; 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				
2448304	Fundamental of Electrical and Mechanical Measurements	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)	
2448304	Fundamental of Electrical and Mechanical Measurements	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: T2448304

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain the basic principles of Electrical and Mechanical measurement</p> <p><i>TSO 1b.</i> Define the terms Accuracy, Precision, Resolutions and errors</p> <p><i>TSO 1c.</i> Measure electrical &amp; mechanical parameters applicable in fire technology</p> <p><i>TSO 1d.</i> Use SI systems of measurement</p>	<p><b>Unit-1.0 Fundamental Concepts of Measurements</b></p> <p>1.1 Introduction to Measurement system and its need</p> <p>1.2 Basic Principles, Knowledge of Accuracy, Precision, Resolutions and errors</p> <p>1.3 Electrical parameters and their roles</p> <p>1.4 Mechanical parameters and their roles</p> <p>1.5 SI System of Electrical and Mechanical Qualities</p>	<b>CO1</b>
<p><i>TSO 2a.</i> Enlist the different instruments used for measuring Current, Voltage and Power</p> <p><i>TSO 2b.</i> Explain the principles of operation and working of measuring instruments</p> <p><i>TSO 2c.</i> Follow the appropriate methods of measurements</p>	<p><b>Unit-2.0 Measurement of Electrical Quantities</b></p> <p>2.1 Classifications of measuring instruments to measure current</p> <p>2.2 Classifications of measuring instruments to measure Voltage</p> <p>2.3 Classifications of measuring instruments to measure Power</p> <p>2.4 Principle of operation and working</p> <p>2.5 Methods of measurements</p>	<b>CO2</b>
<p><i>TSO 3a.</i> Measure the mechanical quantities such as displacement using transducers</p> <p><i>TSO 3b.</i> Explain the types of transducers used for displacement</p> <p><i>TSO 3c.</i> Elaborate the limitations and advantage of using transducers for measurements</p> <p><i>TSO 3d.</i> Measure the vibration using appropriate equipment</p>	<p><b>Unit-3.0 Measurement of Mechanical Quantities</b></p> <p>3.1 Measurement of displacement</p> <p>3.2 Transducers and types</p> <p>3.3 Advantages and limitations of transducers</p> <p>3.4 Measurement of vibration</p>	<b>CO3</b>
<p><i>TSO 4a.</i> Enlist the direct and indirect methods used for measurement of liquid</p> <p><i>TSO 4b.</i> Explain various types of level indicators</p> <p><i>TSO 4c.</i> Use appropriate flow measurement instrument</p>	<p><b>Unit-4.0 Measurement of Liquid and Flow</b></p> <p>4.1 Direct methods and indirect methods</p> <p>4.2 Level indicators and types</p> <p>4.3 Flow measurement</p> <p>4.4 Types of flow measuring instruments</p>	<b>CO4</b>
<p><i>TSO 5a.</i> Measure the acceleration using suitable device/instrument</p> <p><i>TSO 5b.</i> List the equipment used for strain measurement</p> <p><i>TSO 5c.</i> Enlist various gages used for measuring stress</p> <p><i>TSO 5d.</i> Explain the applications of load cell used for force, torque and power</p>	<p><b>Unit-5.0 Electro-Mechanical Measurements</b></p> <p>5.1 Measurement of acceleration</p> <p>5.2 Strain -stress measurements</p> <p>5.3 Gages and types.</p> <p>5.4 Measurement of force, torque and power</p> <p>5.5 Load cell types</p>	<b>CO5</b>

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

**K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2448304**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Handle tools equipment and instruments used for electrical measurements	1.	Measurement of Electrical Quantities: Voltage, Current, Resistance, and Power	CO1, CO3
LSO 2.1 Perform tests on AC and DC current appliances	2.	Analysis of DC & AC current applications and appliances.	CO1, CO2
LSO 3.1 Develop specifications electrical supply equipment	3.	Preparation of specification of Electric Supply in different equipment, Housing hold and Industry	CO3
LSO 4.1 Measure temperature using appropriate tools and devices	4.	Measurement of Temperature using Thermocouple RTDs, and Thermistors	CO2
LSO 5.1 Calculate important parameters such as Force, torque	5.	Measurement of Force, Torque, and Pressure Using Strain Gauges	CO4
LSO 6.1 Measure pressure using suitable gauge /instrument	6.	Measurement of Pressure and Acceleration by Piezoelectric Transducers	CO4
LSO 7.1 Calculate error by analyzing the data and results	7.	Evaluation of Measurement Uncertainties and Error Analysis	CO5
LSO 8.1 Measure the flow of fluid with suitable sensors	8.	Measurement of Fluid Flow Using Flow Meters and Sensors	CO5
LSO 9.1 Detect smoke using appropriate device	9.	Operation of heat detectors and smoke detectors	CO5
LSO 10.1 Rectify the faculty in firefighting system of having electrical and Mechanical devises	10.	Troubleshooting and maintenance of fire safety systems using electrical and mechanical measurements	CO1 to CO5

**L) Suggested Term Work and Self Learning: S2448304** Some sample suggested assignments, micro project and other activities are mentioned here for reference.**a. Assignments:**

- i. Explain the working principle of a moving coil ammeter. Describe the factors that affect its accuracy and sensitivity
- ii. Collect the information about e different types of strain gauges and their applications in mechanical measurement.

**b. Micro Projects:**

- A company is designing a new machine that requires precise measurement of force and displacement. Describe the types of sensors you would recommend for this application and explain your reasoning.

**c. Other Activities:**

## 1. Seminar Topics:

- Sensor-Based Electrical Measurements
- Flow Measurement Techniques: Ultrasonic, Magnetic, and Thermal
- Electrical and Mechanical Sensor Fusion for Multi-Parameter Measurements
- Automotive Measurement Technologies: Sensor Systems and Diagnostics

**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%	20%	-	20%	20%	20%
CO-2	20%	30%	20%	25%	20%	10%	20%
CO-3	30%	25%	20%	25%	20%	15%	20%
CO-4	20%	15%	20%	25%	20%	15%	20%
CO-5	15%	15%	20%	25%	20%	40%	20%
<b>Total Marks</b>	30	70	20	20	10	20	30
			<b>50</b>				

**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 for progressive assessment.

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 Fundamental Concepts of Measurements	08	CO1	10	2	4	4
Unit-2.0 Measurement of Electrical Qualities	10	CO2	20	8	6	6
Unit-3.0 Measurement of Mechanical Qualities	12	CO3	16	4	6	6
Unit-4.0 Measurement of liquid and Flow	10	CO4	12	2	4	6
Unit-5. Electro-Mechanical Measurements	08	CO5	12	4	4	4
<b>Total</b>	<b>48</b>	<b>-</b>	<b>70</b>	<b>20</b>	<b>24</b>	<b>26</b>

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

**O) Suggested Assessment Table for Laboratory (Practical):**

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva - Voce (%)
			PRA* (%)	PDA** (%)	
1.	Measurement of Electrical Quantities: Voltage, Current, Resistance, and Power	CO1, CO3	45	45	10
2.	Analysis of DC & AC current applications and appliances.	CO1, CO2	45	45	10
3.	Preparation of specification of Electric Supply in different equipment, Housing hold and Industry	CO3	45	45	10
4.	Measurement of Temperature using Thermocouple RTDs, and Thermistors	CO2	45	45	10
5.	Measurement of Force, Torque, and Pressure Using Strain Gauges	CO4	45	45	10
6.	Measurement of Pressure and Acceleration by Piezoelectric Transducers	CO4	45	45	10
7.	Evaluation of Measurement Uncertainties and Error Analysis	CO5	45	45	10
8.	Measurement of Fluid Flow Using Flow Meters and Sensors	CO5	45	45	10
9.	Operation of heat detectors and smoke detectors	CO5	45	45	10
10.	Troubleshooting and maintenance of fire safety systems using electrical and mechanical measurements	CO1 to CO5	45	45	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.	Digital Voltmeter	Input range: The digital voltmeter has automatic range selection facility. The input range is from $\pm 1$ V to $\pm 1000$ V. Accuracy: The accuracy is about $\pm 1$ percent for a 3 digit digital voltmeter and $\pm 0.0002$ percent for a 6 digit digital voltmeter. Speed: A digital voltmeter can digitize the signal with a speed of about 1 millisecond. Resolution: The resolution is one part in 106. Stability: 0.002 of the reading for 24 hours. (0-600)V, Moving Iron	01
2.	Ammeter	4-1/2 Digits Panel Flush Mounting AC Ammeter, Size – 96 x 48 mm, For Shunt Operated 75mV or for Direct Operated up to 20A AC. For Shunt Operated the maximum current shall be 1999 A	01, 02
3.	Wattmeter	Accuracy $\pm 1.5 / 2.0$ of FSD Measurable Quantities Active and Reactive Power Pointer deflection $0 - 90^\circ$ Input Full-scale power value $P_w$ or $P_b$ Feasibility factor " $\lambda$ "= $P_w/P_s$ or $P_b / P_s$ Power factor $\cos\phi = 1 \pm 0.01$ for Watt meters & $\sin\phi = 1 \pm 0.01$ for Var meters Voltage Rated voltage + 2% Frequency 45-65 Hz (50 Hz $\pm 0.1\%$ for E1B) Current 20% to 120% of rated current Overload Capacity According to IS: 1248 / IEC 51 Short duration 2 times rated voltage for 5s: 1 overload 10 times rated current for 5s: 1 overload Continuously 1.2 times rated voltage or current Operating Temperature $-10$ to $55^\circ\text{C}$ Storage Temperature $-25$ to $65^\circ\text{C}$ Relative Humidity $< 75\%$ annual average, non-condensing	01,02
4.	Rheostat	Power Ratings :120 Watts to 2500 Watts in single tube. Higher ratings with multiple tubes. Ohmic Value :0.3 $\Omega$ to 25K $\Omega$ Current Range :0.3A to 40A Tolerance : $\pm 10\%$ . Standard. Closer Tolerances Available. Temperature Co-efficient : $\pm 50$ ppm/ $^\circ\text{C}$ to $\pm 200$ ppm/ $^\circ\text{C}$ Lab. Rheostats of (300 $\Omega$ , 1.7 A), (250 $\Omega$ , 3A), (375 $\Omega$ , 2.5A)	01,02
5.	Connecting wires	1.5mm square PVC insulated Copper wire	
6.	Load Box	3 Phase. 10KW, 440V	01, 02, 03
7.	Digital multimeter	Lab. Digital Multimeter of (DC/AC 100 $\mu\text{V}$ -1000 V), (DC/AC 10 $\mu\text{A}$ - 10.00 A), (100 m $\Omega$ -60.00 M $\Omega$ ), (1 pF- 40.00 mF)	01, 02, 03
8.	Temperature Measurement Trainer	Temperature Trainer kit +12-0 012 V 500mA to drive digital integrated circuitry. +5-0—5V 250mA to drive A to D converter. 3 Way rotary switch to select RTD, Thermocouple and Thermister.	04
9.	Strain gauge kit	KIT CONTENTS: STRAIN GAGES (10 PER PKG) SGD-3/350-LY11 (Ribbon Leads) SGD-7/350-LY41 (Solder Pads) KFG-10-120-C1-11L1M2R (Lead Wire)	05

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		BTP-1 (Terminal Pads) BTP-2 (Terminal Pads)	
10.	Cantilever Beam Apparatus	Cantilever span could be 2 meter to 2.5 meter. > The maximum length of cantilever slab shouldn't be more than 2m or 6–6.5 ft. Stainless Steel, weights 100 gm to 1 kg	05
11.	Piezoelectric Transducers	Impedance: ≤500Ω; Voltage: ≤30Vp-p; Operating temperature: -20°C~+60°C Storage temperature: -30°C~+70°C Low Soldering temperature Strain sensitivity: 5V/με Material: Quartz (mostly used)	06
12.	Flow Meter Demonstration Unit	Manometer range: 0-400mm Number of manometer tubes: 8 Orifice plate diameter: 20mm, Variable area meter: 2-20 l/min	08
13.	Battery-operated smoke detectors	9V, 35mA, Sensitivity 1.3% to 2.06% FT, Sound level 85dB/3M	09

## R) Suggested Learning Resources:

### (a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	A course in Electrical and Electronic Measurements and Instrumentation	A. K. Sawhney	Publisher : Dhanpat Rai & Co. (P) Limited ISBN-10: 8177001000 ISBN-13: 978-8177001006
2.	Electrical Measurements & Measuring Instruments	J.B. Gupta	Publisher: S.k. Kataria & Sons ISBN: 8188458260
3.	Electrical And Electronic Measurements And Instrumentation	S. K. Bhattacharya & S. Bhattacharya	Vikas Publishing ISBN: 9789325994010
4.	Electrical and Electronic Measurements and Instrumentation	Er. R. K. Rajput	S. Chand Publishing ISBN : 9789385676017
5.	Mechanical & Electro-Mechanical Measurement Principles	U.S. Military	www.survivablebooks.com, www.armytechnicalmanuals.com, www.armymilitarymanuals.com
6.	Smart Electromechanical Systems	Andrey E. Gorodetskiy	Publisher : Springer Nature Switzerland AG, ISBN-10: 3030970035 ISBN-13: 978-3030970031
7.	Fluid Flow Measurement	Arti Kashyap	Publisher : Scitus Academics LLC ISBN-10: 9781681173740 ISBN-13: 978-1681173740

### (b) Online Educational Resources:

#### 1. Measurements of Electrical Quantities

- URL: <https://www.eolss.net/sample-chapters/c05/E6-08-29.pdf>
- 2. <https://archive.nptel.ac.in/courses/112/103/112103261/>
- 3. <https://www.youtube.com/watch?v=Aaf93BljMRA>
- 4. [https://onlinecourses.nptel.ac.in/noc22\\_ee112/preview](https://onlinecourses.nptel.ac.in/noc22_ee112/preview)

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

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- A) **Course Code** : 2448305(T2448305/S2448305)  
 B) **Course Title** : Explosion and Industrial Fire Safety  
 C) **Pre- requisite Course(s)** :  
 D) **Rationale** :

Industrial fire safety is the set of practices intended to reduce the destruction caused by fire and typical explosions. Fire safety measures include those that are intended to prevent ignition of an uncontrolled fire, and those that are used to limit the development and effects of a fire after it starts. Threats to explosions & fire safety are commonly referred to as fire hazards. A fire hazard may include a situation that increases the likelihood of a fire or may impede escape in the event a fire occurs. The professional who are responsible for industrial fire safety should have a working knowledge of basic fire science and chemistry.

This course on Explosion and fire safety is to provide the basic fundamental of fire and explosion at industrial premises. The course also have scope of the explosions, their types and classifications with common explosive materials available in industrial premises.

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

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

- CO -1** Explain fir/combustion behavior based on its classification.  
**CO -2** Describe the fire characteristics associated with solid, liquids and gaseous fuels.  
**CO -3** Analyze the procedures in firefighting on different types of combustibles.  
**CO -4** Elaborate explosion with its classification.  
**CO -5** Illustrate hydrocarbons and their mixture as explosives at industrial premises.

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

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

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

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

## G) Teaching &amp; 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				
2448305	Explosion and Industrial Fire Safety	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= (1xCIhours) + (0.5xLIhours) + (0.5xNotionalhours)

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

## H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2448305	Explosion and Industrial Fire Safety	30	70	20	30	-	-	150

## Legend:

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

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

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

## Note:

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

I) **Course Curriculum Detailing:** 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: T2448305

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Elaborate fire and different modes of combustions.</p> <p><i>TSO 1b.</i> Explain product of combustion with their toxic properties.</p> <p><i>TSO 1c.</i> Classify the fire based on combustibles materials.</p> <p><i>TSO 1d.</i> Compare the different stages of fire up to fully developed stage.</p> <p><i>TSO 1e.</i> Identify the extinguishing media and fire control theory application in real scene of fire.</p>	<p><b>Unit-1.0 Fire/Combustion Behavior</b></p> <p>1.1 Definition and mode of combustion.</p> <p>1.2 Product of combustion/fires.</p> <p>1.3 Classification of fires.</p> <p>1.4 Fire development stages.</p> <p>1.5 Fire control theory.</p>	<b>CO1</b>
<p><i>TSO 2a.</i> Classify the gaseous flames.</p> <p><i>TSO 2b.</i> Explain Flammability limits and propagation rates for gaseous fire.</p> <p><i>TSO 2c.</i> Classify the liquid fires.</p> <p><i>TSO 2d.</i> Compare the characteristics of burning liquids and liquids pool.</p> <p><i>TSO 2e.</i> Explain flam spread rate over liquid surface.</p> <p><i>TSO 2f.</i> Elaborate the process of Gasification, Ignition, Charring and Melting in solid combustible.</p> <p><i>TSO 2g.</i> Describe the fire retardants materials in enhancing the fire resistance time during fire exposure.</p>	<p><b>Unit-2.0 Fire Characteristics of Gaseous, Liquids and Solids Combustible.</b></p> <p>2.1 Types of gaseous flames.</p> <p>2.2 Flammability limits and propagation rates of premixed flames.</p> <p>2.3 Categories of liquid fires.</p> <p>2.4 Burning liquids and liquids pool.</p> <p>2.5 Flame spread rate over liquid surface.</p> <p>2.6 Gasification, Ignition, Charring and Melting.</p> <p>2.7 Fire retardants.</p>	<b>CO2</b>
<p><i>TSO 3a.</i> Identify the different fire extinguishing agents.</p> <p><i>TSO 3b.</i> Explain the procedure of fire fighting in gaseous flames extinguishment.</p> <p><i>TSO 3c.</i> Elaborate the strategies adopted during firefighting in extinguishment of burning liquids.</p> <p><i>TSO 3d.</i> Describe the procedure and safety during fire extinguishment of burning solids.</p> <p><i>TSO 3e.</i> Classify the special fire situation with their control theory.</p>	<p><b>Unit-3.0 Fire Fighting Procedures.</b></p> <p>3.1 Extinguishing agents.</p> <p>3.2 Extinguishment of gaseous flames.</p> <p>3.3 Extinguishment of burning liquids.</p> <p>3.4 Extinguishment of burning solids.</p> <p>3.5 Special fire situations and safety.</p>	<b>CO3</b>
<p><i>TSO 4a.</i> Explain types of explosions.</p> <p><i>TSO 4b.</i> Classify the explosions and safety parameters.</p> <p><i>TSO 4c.</i> Describe blast wave in Ideal conditions.</p> <p><i>TSO 4d.</i> Explain the salient feature of blast waves.</p> <p><i>TSO 4e.</i> Analyze the explosion energy release and rate of energy release from the source of explosions.</p>	<p><b>Unit-4.0 Explosions</b></p> <p>4.1 Significance of safety during explosion and types of explosions.</p> <p>4.2 Classification of explosions.</p> <p>4.3 Ideal blast wave.</p> <p>4.4 Salient feature of blast waves.</p> <p>4.5 Energy release and rate of energy release in explosions.</p>	<b>CO4</b>

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 5a.</i> Describe explosive due to hydrocarbons.</p> <p><i>TSO 5b.</i> Elaborate Azide, Fulminate, Acetylide and Stephanite with metals radicals as explosive.</p> <p><i>TSO 5c.</i> Describe inorganic substances as explosive.</p> <p><i>TSO 5d.</i> Explain Characteristics of explosive compositions and safety features of hydrocarbons explosion.</p> <p><i>TSO 5e.</i> Compare oxygen content influence in explosion with deficient and enrich conditions.</p>	<p><b>Unit-5.0 hydrocarbons -Condensed Phase Explosion.</b></p> <p>5.1 Explosive from hydrocarbons.</p> <p>5.2 Explosive with radicals of Azide, Fulminate, Acetylide and Stephanite with metals.</p> <p>5.3 In organic substance- Black powder.</p> <p>5.4 Characteristics of explosive compositions.</p> <p>5.5 Enhancing and reduction of oxygen content.</p>	<p><b>CO5</b></p>

**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: S2448305** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

#### a. Assignments:

1. Develop a list of highly explosive combustible material to display in the institute/industry
2. Prepare SOPs of using explosive based firefighting equipment installed in the institute/industry

#### a. Micro Projects:

1. Conduct the fire audit to establish a safety plan of a chemical industry having potential threats of Explosions
2. Conduct a survey and prepares a report of the transportation, loading and unloading of explosive in industries

#### b. Other Activities:

1. Prepare explosive based safety rules for various types of industry
2. Visit a site of explosion due to LPG blast and study the fire safety lapses

#### Seminar Topics:

- Fire behavior after explosion.
- Technologies of fire and extinguishment media.
- Typical combustible Gases, liquids, solid fuel
- Explosion and explosion safety.

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

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

**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 Fire Behavior	8	CO1	10	3	3	4
Unit-2.0 Fire Characteristics of Gaseous, Liquids and Solids Combustible.	8	CO2	10	3	2	5
Unit-3.0 Fire Fighting Procedures.	10	CO3	12	5	2	3
Unit-4.0 Explosions	12	CO4	12	5	6	9
Unit-5.0 Condensed Phase Explosion.	10	CO5	12	4	6	10
<b>Total</b>	<b>48</b>	<b>-</b>	<b>70</b>	<b>20</b>	<b>19</b>	<b>31</b>

**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.	Handbook of Fire and Explosion Protection Engineering Principles for Oil, Gas, Chemical, and Related Facilities	Dennis P. Nolan	Gulf Professional Publishing Paperback ISBN: 9780128160022 9 7 8 - 0 - 1 2 - 8 1 6 0 0 2 - 2 eBook ISBN: 9780128160039 • Fourth Edition • 2019
2.	Essential of Fire Fighting	Carl Goodson and Lynne Murnane	Fire Protection Publisher, 5 <sup>th</sup> Edition ISBN- 978-0-87939-284-0
3.	Principles of Fire Protection Chemistry and Physics	Raymond Friedman	National Fire Protection Association Publisher ISBN: 0-87765-440-9
4.	Explosion and Explosion Safety	K.Ramamurthi	Tata McGraw Hill Publisher ISBN : 978-0-07-070447-3
5.	Fire Technology & Industrial Safety (Part 1) (Hindi) Paperback – 1 January 2015)	R.S.Rathore C.S.Changeriya	Chetan Publication; 2015th edition (1 January 2015)

**b. Online Educational Resources:**

- 1) <https://alison.com/course/chemical-safety-fires-and-explosions>
- 2) <https://www.abhisam.com/preventing-fires-and-explosions-training-course/>
- 3) [https://www.iitr.ac.in/safety/Safety%20Awareness/Fire\\_Safety.pdf](https://www.iitr.ac.in/safety/Safety%20Awareness/Fire_Safety.pdf)
- 4) [https://onlinecourses.nptel.ac.in/noc22\\_me37/preview](https://onlinecourses.nptel.ac.in/noc22_me37/preview)
- 5) <https://www.youtube.com/watch?v=VTfJZ0Y5k2w>
- 6) <https://www.youtube.com/watch?v=ETrWpMuHdtA>

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

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- A) **Course Code** : 2448306(P2448306/S2448306)  
 B) **Course Title** : Summer Internship -I (Common For all Programmes)  
 C) **Pre- requisite Course(s)** :  
 D) **Rationale** :

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

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

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

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

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

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

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

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

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

## G) Teaching &amp; 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				
2448306	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)	
2448306	Summer Internship -I	-	-	10	15	10	15	50

## Legend:

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

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

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

## Note:

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

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

- Industrial Layout
- Organizational Structure
- Corporate Communications
- Strategic, Rolling and Developmental plans
- Maintenance Procedures
- Inventory Control and Management System
- Purchase and Store Procedures
- Major Machinery, Tools, Equipment, Devices, Software, Control System etc.
- Product Development, Manufacturing, Packaging and Delivery
- Project Management
- Operation and Maintenance
- Warehouse Management
- Assembly Line
- Quality Assurance and Testing Cell
- Process/ Software Development/ Fabrication/ Construction Work Management
- Testing and Quality Assurance Practices
- Total quality management
- Callibration and Certification practices
- Safety Practices
- Industrial Acts
- Industrial Grievances
- Behavioral 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
<b>Total</b>		<b>100</b>

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

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

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

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

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

- CO-1** Enumerate salient features and characteristics of the constitution of India.  
**CO-2** Follow fundamental rights and duties as responsible citizen and engineer of the country.  
**CO-3** Analyze major constitutional amendments in the constitution.

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

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

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

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

## G) Teaching &amp; Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400007	Indian Constitution	01	-	-	-	01	01

## Legend:

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

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

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

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

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

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

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

## H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400007	Indian Constitution	25	-	-	-	-	-	25

## Legend:

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

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

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

## Note:

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

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

**J) Theory Session Outcomes (TSOs) and Units: T2400007**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the meaning of preamble of the constitution. TSO 1b. List the salient features of constitution. TSO 1c. List the characteristics of constitution.	<b>Unit-1.0 Constitution and Preamble</b>  1.1 Meaning of the constitution of India. 1.2 Historical perspective of the Constitution of India. 1.3 Salient features and characteristics of the Constitution of India. 1.4 Preamble to the Constitution of India.	<b>CO1</b>
TSO 2a. Enlist the fundamental rights. TSO 2b. Identify fundamental duties in general and in particular with engineering field. TSO 2c. Identify situations where directive principles prevail over fundamental rights.	<b>Unit-2.0 Fundamental Rights and Directive Principles</b>  2.1 Fundamental Rights under Part-III. 2.2 Fundamental duties and their significance. 2.3 Relevance of Directive Principles of State Policy under part-IV.	<b>CO2</b>
TSO 3a. Enlist the constitutional amendments. TSO 3b. Analyze the purposes of various amendments.	<b>Unit-3.0 Governance and Amendments</b>  3.1 Amendment of the Constitutional Powers and Procedure 3.2 Major Constitutional Amendment procedure - 42nd, 44th, 74th, 76th, 86th and 91st	<b>CO3</b>

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

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

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

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

**b. Micro Projects:**

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

**c. Other Activities:**

1. Seminar Topics:
  - Democracy and Political Participation in India
  - Situations where directive principles prevail over fundamental rights.
2. Visits:
  - Arrange Mock Parliament.
3. Design games and simulation on emergencies declared in last thirty years.
4. Group discussions on current print articles.

- Adoption of Article 365 in India.
  - Need of amendments in the constitution.
5. Prepare collage/posters on current constitutional issues.
- Emergencies declared in India
  - Seven fundamental rights
6. Cases: Suggestive cases for usage in teaching:

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

### 7. Self-Learning Topics:

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

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

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

**Legend:**

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

\*\* : Mentioned under point- (N)

# : Mentioned under point-(O)

**Note:**

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

**N) Suggested Specification Table for End Semester Theory Assessment: (Not Applicable)****O) Suggested Assessment Table for Laboratory (Practical): (Not Applicable)**

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

**Q) List of Major Laboratory Equipment, Tools and Software: (Not Applicable)****R) Suggested Learning Resources:****(a) Books:**

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

**(b) Online Educational Resources:**

1. <https://www.coursera.org/learn/principles-of-management>
2. <http://www.legislative.gov.in/constitution-of-india>
3. [https://en.wikipedia.org/wiki/Constitution\\_of\\_India](https://en.wikipedia.org/wiki/Constitution_of_India)
4. <https://www.india.gov.in/my-government/constitution-india>
5. <https://eci.gov.in/about/about-eci/the-setup-r1/>
6. <https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/>
7. <https://main.sci.gov.in/constitution>
8. <https://nios.ac.in/media/documents/srsec317newE/317EL8.pdf>
9. <https://legallaffairs.gov.in/sites/default/files/chapter%203.pdf>
10. [https://www.concourt.am/armenian/legal\\_resources/world\\_constitutions/constit/india/india-e.htm](https://www.concourt.am/armenian/legal_resources/world_constitutions/constit/india/india-e.htm)
11. <https://constitutionnet.org/vl/item/basic-structure-indian-constitution>

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

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- A) **Course Code** : 2452107(T2452107)  
 B) **Course Title** : Basics of Liberal Art (FTS, GT, TE, MIE)  
 C) **Pre- requisite Course(s)** :  
 D) **Rationale** :

The Liberal Art education aims to provide students with a foundational understanding of various aspects of liberal arts, including literature, history, philosophy, and social sciences for holistic approach towards education. The skills and knowledge gained after studying liberal arts can advance their chances in succeeding in selected career. This course of Basics of Liberal Art is designed for diploma graduates to develop certain liberal arts such as critical thinking skills, promote liberal art awareness, and foster creativity.

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

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

- CO-1** Demonstrate knowledge of key concepts and theories in literature, history, philosophy, and social sciences.  
**CO-2** Apply critical thinking skills to evaluate and assess information from diverse sources.  
**CO-3** Use creative thinking to perform disruptive engineering tasks.

- 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	3		
CO-2	-	-	1	-	3	1	3		
CO-3	-	-	1	-	3	11	3		

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

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

## G) Teaching &amp; Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)				
		Classroom Instruction (CI)		Notional Hours (TW+ SL)	Total Hours (CI+TW)	Total Credits (C)
		L	T			
2452107	Basics of Liberal Art	01	-	-	01	01

## Legend:

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

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

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## H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
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2452107	Basics of Liberal Art	25	-	-	-	-	-	25

## Legend:

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

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

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## Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
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**I) Theory Session Outcomes (TSOs) and Units: T2452107**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Define the concept of liberal arts and its significance.</p> <p><i>TSO 1b.</i> Identify the different disciplines encompassed by liberal arts.</p> <p><i>TSO 1c.</i> Enlist the historical development and evolution of liberal arts.</p>	<p><b>Unit-1.0 Introduction to Liberal Arts</b></p> <p>1.1 Definition and significance of liberal arts</p> <p>1.2 Historical development and evolution of liberal arts</p> <p>1.3 Overview of interdisciplinary approaches in liberal arts</p> <p>1.4 Liberal arts education and its benefit</p>	CO1
<p><i>TSO 2a.</i> Analyze information and arguments is essential for success in liberal arts.</p> <p><i>TSO 2b.</i> Analyze assumptions and identify biases</p> <p><i>TSO 2c.</i> Draw logical conclusions from the evidence.</p>	<p><b>Unit-2.0 Critical Thinking</b></p> <p>2.1 The Role of Critical Thinking in Liberal Arts Education</p> <p>2.2 Arguments in Liberal Arts Disciplines, Information Assumptions, biases</p> <p>2.3 Critical Thinking and Interpretation, logical conclusions from the evidence</p> <p>2.4 Media Literacy and Critical Thinking in the Digital Age</p>	CO1, CO2
<p><i>TSO 3a.</i> Devise original ideas and interpretations in give situation</p> <p><i>TSO 3b.</i> Use new and unconventional approaches to problem-solving.</p> <p><i>TSO 3c.</i> Use both primary and secondary sources effectively.</p>	<p><b>Unit-3.0 Creativity</b></p> <p>3.1 Creative Thinking Skills in Education</p> <p>3.2 Primary and Secondary Sources in Research for Academic Studies</p> <p>3.3 Critical Thinking in Research: A Focus on Higher Education</p> <p>3.4 Innovative Approaches to Analysis in Different Academic Fields</p> <p>3.5 Collaborative Research in Academic Settings</p> <p>3.6 Feel free to let me know if you would like further information or if you have any other specific requests!</p> <p>3.7 FDM based 3D printing process details.</p> <p>3.8 Conduct research, Sources of information.</p> <p>3.9 Primary and secondary data sources.</p>	CO1, CO3

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

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

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

**b. Micro Projects:**

1. Perform 3D printing of plastic casing of inhaler used by Asthma patients and estimate the cost.
2. Download 5 videos on 3D printing of different components, watch them and write a report to detail out the steps involved, 3D Printer used, 3D Printing software used, material used, complexity involved, printing time, post processing steps used.
3. Print two pieces of same components using ABS and PLA and compare their strength, surface roughness, weight, and cost.
4. Download two 3D printing free software and try to check their compatibility with your lab printer.

**Other Activities:**

1. Seminar Topics:
  - Commercially available 3D printers and software.
  - Strength of 3D printed Plastic components as compared to Die cast Plastic components.
  - Properties of PLA and ABS 3D printing materials.
  - Reverse engineering application of 3D Printing.
2. Visits: Visit nearby tool room/industry with 3D Printing facilities. Prepare report of visit with special comments of 3D printing technique used, material used, single component/batch production/mass production and cost of printed component.
3. Self-Learning Topics:
  - 3D printing of flexible plastic components.
  - 3D printing of micro/mini components.
  - Conversion of CAD file formats into IGES.
  - 3D scanning process.

**K) Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, 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.

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

**M) Suggested Learning Resources:**

**(a) Books:**

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Liberal Arts and Sciences: Thinking Critically, Creatively, and Ethically	Ed. D., Christopher a Ulloa Chaves	Trafford Publishing, 2014 ISBN: 1490736999, 9781490736990
2.	Art of Creative Thinking	Rod Judkins	Hachette Book Publishing 2015 ISBN: 9781444794489
3.	Introduction to Creativity and Innovation for Engineers	Stuart Walesh	Pearson, 2017 ISBN: 9781292159287

**(b) Online Educational Resources:**

1. [https://onlinecourses.nptel.ac.in/noc21\\_me115/preview](https://onlinecourses.nptel.ac.in/noc21_me115/preview)

**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. 3D Printing Projects DK Children; Illustrated edition, 2017
2. The 3D Printing Handbook: Technologies, design and applications Ben Redwood, Filemon Schöffer, Brian Garret, 3D Hubs; 1st edition, 2017
3. 3D Printer Users' Guide

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