Curriculum of Diploma Programme

in

Mechanical Engineering

J.P. Institute Of Technology

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

State Board of Technical Education (SBTE), Bihar

Semester - III

Semester – III

Teaching & Learning Scheme

Board of Study	Course Codes	Course Titles	Teaching & Learning Scheme (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
	2425301	**Manufacturing Engineering**	3	-	4	2	9	6
	2425302	**Material Science & Engineering**	2	1	-	2	5	4
	2425303	**Strength of Materials for Mechanical Engg. (ME, Me (Auto))**	3	-	4	2	9	6
	2425304	**Basic Thermodynamics (ME, ME (Auto))**	2	1	4	2	9	6
	2425305	**Computer Aided Drafting andModeling (ME, ME (Auto))**	-	-	4	2	6	3
	2425306	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	2	2	4	2
	2400207	**Indian Constitution** (Common for All Programmes)	1	-	-	-	1	1
	2400108	**Essence of Indian Knowledge System and Tradition** (Common for All Programmes)	1	-	-	-	1	1
	2400110	**Community/ Society Development** (Non-exam course)	1	-	-	-	1	1
Total			**13**	**2**	**18**	**12**	**45**	**30**

Legend:

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

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, work shop, 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= (1x 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

Board of Study	Course Codes	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)	
	2425301	**Manufacturing Engineering**	30	70	20	30	20	30	200
	2425302	**Material Science & Engineering**	30	70	20	30	-	-	150
	2425303	**Strength of Materials for Mechanical Engg. (ME, Me (Auto))**	30	70	20	30	20	30	200
	2425304	**Basic Thermodynamics (ME, ME (Auto))**	30	70	20	30	20	30	200
	2425305	**Computer Aided Drafting andModeling (ME, ME (Auto))**	-	-	20	30	20	30	100
	2425306	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	10	15	10	15	50
	2400207	**Indian Constitution** (Common for All Programmes)	-	-	25	-	10	15	50
	2400108	**Essence of Indian Knowledge System and Tradition** (Common for All Programmes)	25	-	-	-	-	-	25
	2400110	**Community/ Society Development** (Non-exam course)	25	-	-	-	-	-	25
Total			**170**	**280**	**135**	**165**	**100**	**150**	**1000**

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 becarried 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 **: 2425301 (T2425301/P2425301/S2425301)**

B) Course Title **:** Manufacturing Engineering

C) Pre- requisite Course(s) **:** Mechanical Workshop Practice, Mechanical Properties of Materials

D) Rationale **:**

Through manufacturing processes the raw material is converted into a finished product. Knowledge of basic manufacturing processes such as Casting, Forming, Welding, and Machining is essential for students to perform duties in manufacturing industries/units. The basic knowledge of different manufacturing processes is essential to select the most appropriate process and related parameters for getting the desired results in terms of converting the raw material to finished product as per the requirements. This course on manufacturing engineering aims at providing knowledge regarding different types of manufacturing processes and use of related machines, equipment and tools safely. The knowledge gained through this course will also help the students to take up advanced and manufacturing related courses in the next semesters.

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

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

- **CO-1** Select suitable manufacturing process to produce various components.
- **CO-2** Prepare product using different casting processes.
- **CO-3** Prepare product using different forming processes.
- **CO-4** Use joining process to produce jobs.
- **CO-5** Machine jobs using machine tools like Lathe, Drilling, Milling, Shaping, Slotting etc.
- **CO-6** Perform estimation and costing related calculations for components produced from mentioned four manufacturing processes.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

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			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
Mechanical Engineering	**2425301**	Manufacturing Engineering	03	-	04	02	09	06

Legend:

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

J) Theory Session Outcomes (TSOs) and Units: T2425301

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Classify manufacturing processes. *TSO 1b.* Explain the given basic conventional manufacturing process. *TSO 1c.* Describe the given mechanical property. *TSO 1d.* Select suitable conventional manufacturing process for the given application with justification.	**Unit-1.0 Introduction to Manufacturing Processes** 1.1 Classification of basic manufacturing process based on Formative, Subtractive and Additive manufacturing processes; Chip-less and Chip-removal processes, Primary and Secondary manufacturing processes; Generating & Forming processes; Conventional and Non-Conventional Manufacturing Processes 1.2 Factors which influence selection of manufacturing process for a particular application. 1.3 Recall mechanical properties of metals.	CO1
TSO 2a. Explain the given casting process. *TSO 2b.* Select pattern and allowances for the given application with justification. *TSO 2c.* Interpret the color coding on pattern and core. *TSO 2d.* Explain the given property(ies) of moulding sand. *TSO 2e.* Explain the method of green sand mould preparation. *TSO 2f.* Explain the moulding method and working of the given moulding machine. *TSO 2g.* Explain the use of the given core. *TSO 2h.* Select suitable furnace for the given application with justification. *TSO 2i.* Explain the importance of gates and risers. *TSO 2j.* Find out pouring, solidification time and size of riser. *TSO 2k.* Select appropriate casting process for the given application with justification. *TSO 2l.* Identify casting defects and explain their causes. *TSO 2m.* Select a suitable inspection method for identifying given defects in the given casting with justification. *TSO 2n.* Perform estimation and costing related calculations for the given product to be cast by the given casting method.	**Unit-2.0 Casting Processes** 2.1 Introduction to casting, advantages, and disadvantages of casting. 2.2 Pattern, types of patterns, pattern materials, pattern allowance, colour code 2.3 Moulding sand constituents and its types, properties of moulding sand, moulding sand preparation, moulding tools and moulding boxes, types of moulds-green sand mould, dry sand mould, loam sand mould 2.4 Methods of moulding, Moulding machines; Jolting – Squeezing – Sand slinger, Construction and working principle. 2.5 Cores: Essential qualities of core materials, core sand preparation, core binder, core boxes, co2 process of core making, types of cores 2.6 Melting furnace; Blast furnace, Cupola furnace, Crucible furnace, Pit Furnace, Induction Furnace. 2.7 Casting processes: Green sand Casting, Permanent mould casting, Shell mould casting, Investment casting, Centrifugal casting, 2.8 Gating system, types of gating system, design of riser 2.9 Defects in casting: causes and remedies. 2.10 Inspection of castings: Visual inspection, pressure test, magnetic particle inspection, dye penetration inspection, Radiographic inspection, ultrasonic inspection. 2.11 Safety precautions in metal casting. 2.12 Estimation and costing of casting components.	CO2, CO6
TSO 3a. Explain metal forming and nature of plastic deformation. *TSO 3b.* Explain Cold and Hot working processes and their effects on metal properties.	**Unit-3.0 Metal Forming Processes** 3.1 Introduction, nature of plastic deformation. 3.2 Bulk and Sheet metal forming processes.	CO3, CO6

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3c. Differentiate Bulk and Sheet metal forming processes. *TSO 3d.* Explain the given Bulk forming process. *TSO 3e.* Calculate major parameters related to the given Bulk forming process (Drop forging, Rolling, Extrusion, Drawing). *TSO 3f.* Select relevant Bulk forming process for the given application or component with justification. *TSO 3g.* Explain the given Sheet metal forming process. *TSO 3h.* Calculate main parameters related to the given Sheet metal forming process (Punching-Blanking, Deep Drawing, and Bending). *TSO 3i.* Select relevant Sheet metal forming process for the given application or component with justification. *TSO 3j.* Perform estimation and costing related calculations for the given product to be formed using bulk and sheet metal forming method.	3.3 Hot working, cold working – advantages and disadvantages of hot working and cold working. 3.4 Bulk metal forming processes: Rolling, Forging (Smith forging, Drop forging, Upset forging), Extrusion, Drawing. 3.5 Press Working: Types of presses – mechanical and hydraulic presses – press tools and accessories, press working operations. 3.6 Sheet metal forming processes (Press tools operations): Shearing, Blanking-Punching, Embossing-Coining, Piercing, Trimming, Shaving, Nibbling, Notching, Lancing, Deep drawing, Spinning, Bending, Stretch forming, 3.7 Estimation and costing of metal forming components.	
TSO 4a. Classify different joining processes. *TSO 4b.* Explain the given Oxy-acetylene welding flame(s). *TSO 4c.* Describe Oxy-acetylene welding, related equipment and material. *TSO 4d.* Describe the given Arc welding process (Manual metal arc welding, Inert-gas shielded arc welding- TIG and MIG, Submerged arc-welding), related equipment and materials. *TSO 4e.* Explain the process of resistant welding (Spot and Seam), related equipment and materials. *TSO 4f.* Explain the process and application of Thermit welding, Friction welding, Explosion welding, Brazing, and Soldering. *TSO 4g.* Suggest appropriate welding process for the given application with justification. *TSO 4h.* Identify weld defects and their causes. *TSO 4i.* List safe practices during welding processes. *TSO 4j.* Perform estimation and costing related calculations for the given product to be welded using different welding processes.	**Unit-4.0 Joining Processes** 4.1 Introduction to Joining Processes: Permamnet and Temporary; Welging, Soldering, Brazing, Adhesive bonding. 4.2 Classification of welding processes, types of welded joints. 4.3 Gas welding: Oxy-acetylene welding, types of flame, Oxy-acetylene welding equipment, filler rod, Gas cutting. 4.4 Arc welding: Principle of arc creation, Arc welding equipment, electrodes, arc blow, Types of Arc welding process. Working principle, equipment, process parameters, applications of: Manual metal arc welding (flux coated electrodes), Inert-gas shielded arc welding, Tungsten inert-gas welding (TIG), Metal inert-gas arc welding (MIG), Submerged arc-welding, Plasma arc welding. 4.5 Resistance welding – Butt, Seam, Spot, Projection and Percussion. 4.6 Other welding processes: Thermit welding, Friction welding, Explosion welding, Forged welding, Friction Welding. 4.7 Brazing, soldering and Adhesive bonding. 4.8 Effects of welding heat-Heat affected zone 4.9 Weld defects and their causes. 4.10 Safety precautions in welding. 4.11 Estimation and costing of welded components	CO4, CO6
TSO 5a. Explain chip formation and types of chips. *TSO 5b.* Explain mechanics of orthogonal metal cutting. *TSO 5c.* Explain cutting tool geometry and tool nomenclature. *TSO 5d.* Explain tool materials and tool wear. *TSO 5e.* Estimate tool life for the given values of	**Unit-5.0 Machining and Machine Tools** Machining: 5.1 Introduction to metal cutting. 5.2 Chip formation and types of chips. 5.3 Mechanics of orthogonal metal cutting 5.4 Cutting tool material and geometry	CO5, CO6

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
speed fee and DoC. *TSO 5f.* Select suitable cutting fluid for the given situation. *TSO 5g.* Explain the method of application of the given cutting fluid. *TSO 5h.* Explain the operation of the given lathe machine. *TSO 5i.* Explain the function of the given Lathe machine part(s). *TSO 5j.* Explain the given Milling machine operation and the tool used. *TSO 5k.* Explain the function of the given Milling machine part(s). *TSO 5l.* Describe the given hole making operation(s) (drilling, reaming, boring, tapping). *TSO 5m.* Explain the working of the given Shaping/ Planing/Slotting machine. *TSO 5n.* Explain use of jigs and fixtures. *TSO 5o.* Calculate Speed, Feed, DoC in the given operation to be performed on Lathe/Milling/Drilling/Shaping machine. *TSO 5p.* Calculate machining time required to produce the given part using Lathe, Milling, Drilling and Shaping machine(s). *TSO 5q.* Perform estimation and costing related calculations for the given product to be machined using different machine tools.	5.5 Tool wear and tool life. 5.6 Cutting fluids, types of cutting fluids, selection of cutting fluid, method of application of cutting fluids Machine tools: 5.7 Lathe machine: introduction to lathe machine, types of lathe machine, basic parts and function, basic operations and tools. 5.8 Milling machine: introduction to milling machine, types of milling machine, basic parts and function, basic operations and tools 5.9 Hole making operation: drilling, reaming, boring, tapping. 5.10 Introduction and application of shaper, planer, slotting machine. 5.11 Introduction and application of jigs and fixtures 5.12 Estimation and costing of machining components.	

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2425301

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Identify type of pattern *LSO 1.2.* Calculate pattern allowances as per the given requirement and material. *LSO 1.3.* Prepare pattern using all the required allowances as per the given drawing.	1.	Prepare a single piece pattern considering the shrinkage allowances, draft allowance, machining allowances and shake allowances	**CO2**
LSO 2.1. Identify the ingredients of green sand moulding. *LSO 2.2.* Identify different types of pattern. *LSO 2.3.* Use moulding boxes and other tools to create green sand mould. *LSO 2.4.* Prepare green sand mould using the given pattern. *LSO 2.5.* Withdraw pattern from the sand. *LSO 2.6.* Provide provisions for Gating system, Runner and Riser in the sand mould.	2.	Prepare a green sand mould using the following patterns: • Single piece pattern, • Multi piece pattern, • Match plate pattern, • Gated pattern, • Sweep pattern, • Loose piece pattern,	**CO2**
LSO 3.1. Interpret the drawing of the component. *LSO 3.2.* Prepare sound green sand mould with gating system and riser. *LSO 3.3.* Use furnace to melt the metal at pouring temperature. *LSO 3.4.* Pour the molten metal with safety and in minimum time inside the mould cavity.	3.	Produce a simple part using green sand casting and single piece pattern as per the given component drawing.	**CO2**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 3.5. Monitoring solidification of casting and remove the casted part from the mould without damaging the part. *LSO 3.6.* Cleaning the casted part.			
LSO 4.1. Select the recrystalisation temperature for the given metal. *LSO 4.2.* Select appropriate hot/cold forming process and related parameters. *LSO 4.3.* Produce part using the selected hot/cold forming process.	4.	Produce a simple job using any cold/hot working forming process.	**CO3**
LSO 5.1. Select appropriate die and punch combination. *LSO 5.2.* Select process parameters. *LSO 5.3.* Hold the sheet properly in the press tool. *LSO 5.4.* Produce the part using the required sheet metal forming process.	5.	Prepare a simple job like washer etc. using any sheet metal forming process (press tool operations)	**CO3**
LSO 6.1. Arrange the oxy-accetylene welding setup. *LSO 6.2.* Set the welding process parameters. *LSO 6.3.* Develop appropriate flame type as per metal. *LSO 6.4.* Set the sheets in Lap/Butt/T positions. *LSO 6.5.* Perform welding *LSO 6.6.* Follow safety practices.	6.	Prepare the following joints using Oxy-acetylene gas welding process. • Lap joint, • Butt joint • T joint	**CO4**
LSO 7.1. Arrange the Arc welding setup. *LSO 7.2.* Fix the proper flux coated electrode in the holder. *LSO 7.3.* Set the welding process parameters. *LSO 7.4.* Maintain proper acr for welding. *LSO 7.5.* Set the plates in Lap/Butt/T positions. *LSO 7.6.* Perform welding *LSO 7.7.* Follow safety practices.	7.	Prepare the following joints using Manual Arc welding process. • Lap joint, • Butt joint • T joint	**CO4**
LSO 7.8. Arrange the TIG/MIG welding setup. *LSO 7.9.* Set the TIG/MIG welding process parameters. *LSO 7.10.* Set the plates/pipes in Lap/Butt/T positions. *LSO 7.11.* Perform welding *LSO 8.1.* Follow safety practices.	8.	Prepare the following joints using TIG/MIG welding process. • Lap joint, • Butt joint • T joint	**CO4**
LSO 7.12. Arrange the SS welding setup. *LSO 7.13.* Set the SS welding process parameters. *LSO 7.14.* Set the SS rods/pipes in Lap/Butt/T positions. *LSO 7.15.* Perform SS welding *LSO 9.1.* Follow safety practices.	9.	Prepare a Balcony grill using welding of Stainless Steel (SS) pipes.	**CO4**
LSO 7.16. Arrange the Spot welding setup. *LSO 7.17.* Set the Spot welding process parameters. *LSO 7.18.* Set the plates in spot welding machine. *LSO 7.19.* Perform Spot welding *LSO 10.1.* Follow safety practices.	10.	Perform Spot welding operation.	**CO4**
LSO 7.20. Arrange the Gas cutting setup. *LSO 7.21.* Set the Gas cutting process parameters and flame. *LSO 7.22.* Set the plates for cutting as per drawing. *LSO 7.23.* Perform Gas cutting	11.	Perform gas cutting operation on a sheet as per the given drawing.	**CO4**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 11.1. Follow safety practices.			
LSO 7.24. Arrange Solder/Braze and Soldering/Brazing tool. *LSO 7.25.* Choose and set appropriate temperature for Soldering/Brazing. *LSO 7.26.* Apply flux. *LSO 7.27.* Set the parts/crack for Soldering/Brazing. *LSO 7.28.* Perform Soldering/Brazing. *LSO 12.1.* Follow safety practices.	12.	Make a joint using Soldering/Brazing.	**CO4**
LSO 13.1. Identify all the 6 tool angles and nose radius. *LSO 13.2.* Use Tool Makers microscope *LSO 13.3.* Grind all 6 angles as per given values.	13.	Grind the angles on a single point cutting tool as per drawing using tool makers microscope and grinder.	**CO5**
LSO 14.1. Interpret the drawing *LSO 14.2.* Setup the Lathe for the given operation. *LSO 14.3.* Choose the correct work holding device. *LSO 14.4.* Choose suitable tools for the given Lathe operation. *LSO 14.5.* Perform centering of the job. *LSO 14.6.* Set machining process parameters for the given lathe operation. *LSO 14.7.* Perform the given Lathe operation (Facing, Step Turning, Taper turning, Chamfering, Groove Cutting, Knurling, Thread Cutting). *LSO 14.8.* Follow safety practices.	14.	Produce parts on Lathe machine with following operations as per the given drawing: • Facing, Step Turning, Taper turning and Chamfering • Groove Cutting & Knurling • Thread Cutting	**CO5**
LSO 15.1. Interpret the drawing *LSO 15.2.* Setup the Milling machine for the given operation. *LSO 15.3.* Choose the correct work holding device. *LSO 15.4.* Choose suitable cutter for the given Milling operation. *LSO 15.5.* Set machining process parameters for the given Milling operation. *LSO 15.6.* Perform the given Milling operation (Pocket cutting, Groove cutting). *LSO 15.7.* Follow safety practices.	15.	Produce parts on Milling machine with following operations as per the given drawing: • Pocket cutting • Groove Cutting	**CO5**
LSO 16.1. Interpret the drawing *LSO 16.2.* Setup the Drilling/Boring machine for the given operation. *LSO 16.3.* Choose the correct work holding device. *LSO 16.4.* Choose suitable bit/reamer/tap for the given Hole related operation. *LSO 16.5.* Set process parameters for the given Hole operation. *LSO 16.6.* Perform the given hole operation (Hole making, Boring, Reaming, Tapping). *LSO 16.7.* Follow safety practices.	16.	Perform following hole making, finishing and threading operations as per the given drawing: • Hole making • Boring • Reaming • Tapping	**CO5**
LSO 17.1. Interpret the drawing *LSO 17.2.* Setup the Shaper for the given operation. *LSO 17.3.* Choose the correct work holding device. *LSO 17.4.* Choose suitable tools for the given		Perform following operations on Shaping machine per the given drawing: • Key way cutting • Dove tail groove cutting	**CO5**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
Shaper operation. *LSO 17.5.* Perform the positioning of the selected tool in the Shaper tool post. *LSO 17.6.* Set machining process parameters for the given Shaper operation. *LSO 17.7.* Perform the given Shaper operation (Key way cutting, Dove tail groove cutting). *LSO 17.8.* Follow safety practices.			

L) Suggested Term Workand Self Learning: S2425301 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.

- Discuss the advantages and limitations of chip-less and chip-removal processes of manufacturing.
- Prepare the list of domestic and industrial applications of various generating and forming processes of manufacturing.
- List out at least 10 applications of chip-less processes of manufacturing.
- Identify the factors affecting the selection of pattern material for a given application.
- Compare and prepare a chart showing the applications of various types of patterns.
- Identify the need of core prints.
- Sketch the gating system for pouring metal in a casting.
- Explain the causes and remedies of common casting defects.
- Explain different casting processes.
- Solve numerical problems on forming parameters related to Bulk and Sheet metal forming processes.
- Compare the cold working and hot working of metals.
- Explain the importance of recrystallisation temperature in mechanical working of metals.
- Prepare a list of methods used for production of pipes and tubes.
- Prepare a chart showing the different sheet metal operations.
- Explain different Bulk and Sheet metal forming processes.
- Solve simple numerical problems on forming parameters related to Bulk and Sheet metal forming processes.
- List the advantages, disadvantages and applications of welding over other joining processes.
- Compare the merits, demerits and applications of MIG and TIG.
- Distinguish Thermit welding from Manual arc welding.
- Compare spot and seam welding.
- Explain different Welding processes.
- Solve simple numerical problems on welding parameters related to different welding processes.
- Explain the effect of various tool angles on metal cutting.
- Prepare a list of commonly used cutting fluid and lubricants in given conditions.
- Solve numerical problems using Taylor's tool life equation.
- Solve simple numerical problems on Speed, Feed, Doc related to different machining operations.
- Write the specifications of shaper, slotter and planner available in your institute workshop.
- Perform estimation and costing related calculations for the given product manufactured by any or

combination of four mentioned basic manufacturing processes.

b. Micro Projects:

- Surf www and collect five videos related to manufacturing of different domestic and industrial components and submit it to course coordinator. (Individual student Assignment).
- Collect information of manufacturing industries/workshops/shops in your city and vicinity.
- Prepare a single point cutting tool using eraser and paper cutter/blade.
- Collect photographs of all the cutting tools generally used in today's industries with CBN, PCBN, TC inserts (group work with group size of five students each)
- Surf www and identify five domestic/industrial components produced by casting processes. Write steps of its manufacturing and materials, machines and tools used. (Individual student Assignment).
- Prepare a chart to show the different tools used for making patterns.
- Prepare a chart showing the various casting defects and ways to prevent them.
- Surf www and identify five domestic/industrial components produced by forming processes. Write steps of its manufacturing and materials, machines and tools used. (Individual student Assignment)
- Adjust stroke length of quick return mechanism of shaping machine. Record time required for various stroke lengths.
- Prepare a chart of recommended cutting parameters and cutting tools used for Shaping, Planning and slotting of Steel, Brass, Aluminum, Copper, Cast Iron and their alloys.
- Collect videos of manufacturing of different components which involve Shaping, Planning and Slotting operations.
- Collect/download at least four different machine tool manufacturer's catalogues and at least one catalogue each of cutting tool, work holding device and tool holder related to Shaping machine.
- Collect videos of manufacturing of different components which involve Milling operations.
- Collect/download at least four different machine tool manufacturer's catalogues and at least one catalogue each of cutting tool, work holding device and tool holder related to Milling machine.

c. Other Activities:

1. Seminar Topics:
   - Additive and Subtractive manufacturing processes
   - Blow molding
   - Plastic injection machines
   - Investment Casting
   - Shell Casting
   - Various extrusion machines.
   - Various forging machines.
   - Different deep drawing punches and dies.
   - Welding of Stainless Steel
   - Procedure to measure cutting forces in lathe and Milling operations using dynamometers.

2. Visits:
   - Visit a nearby industry/workshop to identify and list the various types of manufacturing processes used.
   - Visit a nearby foundry and prepare a report comprising of details (type, material, process, etc) of items produced, quantities, consumables and equipment used with specification, process parameters being used.
   - Visit a nearby Rolling mill/allied manufacturing processes industry and prepare a report comprising

of details(type, material, process, etc) of items produced, quantities, different sections, equipments used with specification, process parameters being used.

- Visit a nearby fabrication industry and prepare a report comprises of types of item produced, quantities, different sections, equipments used with specification and consumables.
- Visit a nearby industry or your institute's workshop and identify the different types of Machine tools, Cutting tools, Measuring tools, cutting fluids in use.
- Visit any industry and estimate tool wear for any mass-produced component.

3. Self-learning topics:

- Various Mechanical engineering materials.
- Slush Casting
- Deep Drawing,
- Stretch Forming
- Resistance welding
- Spinning on Lathe
- Internal Turning
- Gear cutting on Milling

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

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

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Manufacturing Processes	06	CO1	06	3	-	3
Unit-2.0 Casting Processes	10	CO2, CO6	15	4	4	7
Unit-3.0 Metal Forming Processes	10	CO3, CO6	15	4	4	7
Unit-4.0 Joining Processes	10	CO4, CO6	16	4	5	7
Unit-5.0 Machining and Machine Tools	12	CO5, CO6	18	5	5	8
Total	**48**	**-**	**70**	**20**	**18**	**32**

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

O) Suggested AssessmentTable for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Prepare a single piece pattern considering the shrinkage allowances, draft allowance, machining allowances and shake allowances	CO2	40	50	10
2.	Prepare a green sand mould using the following patterns: • Single piece pattern, • Multi piece pattern, • Match plate pattern, • Gated pattern, • Sweep pattern, • Loose piece pattern,	CO2	40	50	10
3.	Produce a simple part using green sand casting and single piece pattern as per the given component drawing.	CO2	40	50	10
4.	Produce a simple job using any cold/hot working forming process.	CO3	40	50	10
5.	Prepare a simple job like washer etc. using any sheet metal forming process (press tool operations)	CO3	40	50	10
6.	Prepare the following joints using Oxy-acetylene gas welding process. • Lap joint, • Butt joint • T joint	CO4	40	50	10
7.	Prepare the following joints using Manual Arc welding process. • Lap joint, • Butt joint • T joint	CO4	40	50	10
8.	Prepare the following joints using TIG/MIG welding process. • Lap joint, • Butt joint	CO4	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
	• T joint				
9.	Prepare a Balcony grill using welding of Stainless Steel (SS) pipes.	CO4	40	50	10
10.	Perform Spot welding operation.	CO4	40	50	10
11.	Perform gas cutting operation on a sheet as per the given drawing.	CO4	40	50	10
12.	Make a joint using Soldering/Brazing.	CO4	40	50	10
13.	Grind the angles on a single point cutting tool as per drawing using tool makers microscope and grinder.	CO5	40	50	10
14.	Produce parts on Lathe machine with following operations as per the given drawing: • Facing, Step Turning, Taper turning and Chamfering • Groove Cutting & Knurling • Thread Cutting	CO5	40	50	10
15.	Produce parts on Milling machine with following operations as per the given drawing: • Pocket cutting • Groove Cutting	CO5	40	50	10
16.	Perform following hole making, finishing and threading operations as per the given drawing: • Hole making • Boring • Reaming • Tapping	CO5	40	50	10
17.	Perform following operations on Shaping machine per the given drawing: • Key way cutting • Dove tail groove cutting	CO5	40	50	10

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

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

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

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

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Green Sand Moulding setup, Casting Setup and Patterns	Foundry tools and equipments – hand riddle, shovel, Hand, peen & floor rammer, sprue pin, strike off bar, mallet, draw spike, vent rod, lifters, trowels, slicks, smoothers, swab, spirit level, gate cutter, gaggers, nails and wire pieces, clamps, cotters and wedges, Molding box, crucible etc.	1, 2,3
3.	Extruder/Drawing Machine	Standard size	4
	Hot Forging equipment	Standard hot forging press suitable for forging small parts complete with all tools and accessories.	5
4.	Punching- Blanking Press	1 - 5 ton capacity suitable for small products like washers etc. Dies and Punches	5
5.	Arc Welding Machine	AC transformer − Step down, oil cooled, 3-phase, 50 Hz, Current rating = 50-400 A, Open circuit voltage = 50-90 V, Energy consumption = 4 kWh per kg of metal deposit, Power factor = 0.4, Efficiency = 85 %. Electrode Holder, Shield, Chipping hammer, Wire Brush, File eyc.	7
6.	TIG welding setup	3 phase, 230-415 Volt	8, 9
7.	MIG welding setup	Standard MIG welding machine for welding of low carbon steel, stainless steel, aluminium etc.	8, 9
8.	Spot Welding Setup	Air cooled transformer Easy operation and maintenance with pedal-level type spring-press structure Adjustable welding time, easy welding repeated Suitable for low carbon steel, wire, stainless steel plate etc. Input voltage(V): 220 Rated input capacity (KVA): 10 Adjusting series: 7 Rated duty cycle (%): 20 Arm stretch length(mm): 180 Electrode pressure (Kg): 120 Welding thickness(mm): 0.3+0.3 ~ 2+2 Usable electrode(mm): 81 Phase: 1 PH	10
	Seam Welding Machine	75 KVA, Weld head: Cylinder dia 100 mm, stroke 100 mm,	10
9.	Oxy-acetylene welding and cutting setup	Gas cylinder with full of Acetylene Gas Gas cylinder with full of Oxygen Gas Hose Pipe: 30 m Pressure Gauge set (Oxy & Acetylene Regulator) Welding Torch set Cutting Torch set Other necessary standard accessories for welding and cutting operation	6,11
10.	Soldering Station, Solder, Flux	Super fast heating 200 ºC ~ 480 ºC (392 °F ~ 896 °F), Precise, Stable, Rapid Heating & Instant Temp., Compensation, Temperature Stability: ± 1 ºC (Stationary air, no load), Tip to Ground Resistance: < 2 Ω, Tip to Ground Potential: < 2 mV Max. Power: 60 W (Unit, Max.). Sold. Iron: 50 W (24 V AC) Soft Touch Up/Down Keys ensure precise setting of Temperature and a key card to protect their settings. S.M.D. Hot Tweezer	12

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		Pointed Tip	
11.	Brazing rod, Braze, Flux		12
12.	Tool Makers microscope	Monocular optical tube, erect image, angle reading: min 6', Range 360 degree, Eyepiece magnification 15x, Objective magnification 2x, Light source Tungstan bulb	13
	Tool and Cutter grinder	Longitudinal travel of table: 230mm Cross travel of saddle: 180mm Vertical adjustment of wheel head: 120mm Rotary angle of wheel head: 360° Rotary angle of up-down spindle: 360° Working table area: 620 x 190mm Size of wheel: 180 x 25 x 31.75mm 125 x 50 x 31.75mm Speed of wheel: 3,600 RPM Motor: 3/4 HP, 110V / 220V / 380V	13
13.	Lathe machine	Center Lathe Machine (Length between centers: 2000 mm)	14
	Different Single point and multi point cutting tools	Single point cutting tool with various inserts like WC Coated Carbide, CBN, PCBN Milling Cutter, Drill Bits, Reamers, Taps, Shaper tool, Grinding wheels	14
14.	Milling machine with required set of work holding devices, cutting tools, accessories and tool holders.	Face of Body-12" Surface of Table-12"x54" size of tee slots No-1/2"=3 Cross-12 Vertical Traverse-24" Longitudinal automatic-30" Table Rotation side to side-45"-0-45" Standard Arbour-1" Taper of Spindle-ISO-40 No. of Spindle Speed-9 Range of Spindle speed RPM-45 TO 1000 No. of Feed Longitudinal-3.S.F.M Motor H.P & R.P.M: 3 H.P/1440 RPM	15
15.	Drilling machine with required set of work holding devices, cutting tools, accessories and tool holders.	Drilling Capacity: 40 mm Column Diameter: 75 mm Spindle Hole Taper: MT-2 Spindle Speeds: 50–3000 RPM Spindle Nos. To table Dist.: 605 mm Spindle Center To Pillar: 206 mm Table Size: 260 mm Motor: 0.5 HP	16
16.	Shaper with required set of work holding devices, cutting tools, accessories and tool holders.	Length of stroke: Max.500 mm No. of Ram cycles / min.: Max.140 strokes/min. Motor Power: A.C. 7.5 H.P.	17
	Grinding machine	Working Surface of the table- 225 x 450mm Maximum Height from Table to Grinding Wheel- 275mm Vertical Feed Least Count- 0.01mm Micro Feed Least Count- 0.002mm Spindle Speed- 2800 RPM Electric Motor recommended- 1 HP - 2800 RPM	All

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
	Lathe tool dynamometer	Forces in X - Y - Z directions will be shown individually Capacity: X, Y, Z - Force 500 Kg Dynamometer Mounting hole-25 mm dia Hole to mount sensor on tool post. Excitation: 10v Dc Linearity: 2% Accuracy: 2% Cross-Sensitivity: 5% Max. Overload: 150 %	14
	Milling tool dynamometer	Forces in X - Y - Z directions will be shown individually Capacity: X, Y, Z - Force 500 Kg Job Mounting holes M10 provided to fix machine vise. Mounting Type-350(L) x 350(W) x 100(H)mm. Dynamometer Mounting hole-25 mm dia Hole to mount sensor on tool post. Excitation: 10v Dc Linearity: 2% Accuracy: 2% Cross-Sensitivity: 5% Max. Over Load: 150 %	15
	Drill tool dynamometer	Capacity- 500Kg Thrust load, 20 Kgm-torque. Mounting- Flang type to mount on the machine bed. Sensor Type- Straingauge based 350Ω bridge. Job Mounting- Slots provided on the flange plate to mount the machine vise. Excitation: 10v Dc Linearity: 2% Accuracy: 2% Cross-Sensitivity: 5% Max. Over Load: 150 %	16
	Thermometer	Infrared thermometer Temperature range: - 30°C to 500°C D/S ratio – 10:1 IP40 dust & water resistant	All
	Equipment and chart for Acceptance test of machine tools	Equipment and chart for Acceptance test of machine tools, Dial Gauges, Sprit Levels, Test Mandrels, Straight edges. True running of the spindle, Perpendicularity/ Parallelism between spindle and base plate, Perpendicularity between the feed movement and the baseplate/guideways,	All
	Vernier Calipers & Micrometers	Vernier Calipers: stainless steel body, Range: 0-150mm Resolution: 0.1mm Micrometer: Material- Carbon Steel Graduated to read up to 25mm in 0.01mm divisions with screw pitch of 0.5mm, ratchet lock nut	All
	Vernier height gauge.	Carbide tipped scriber. With fine adjustment. Made of stainless steel or carbon steel.	All
	Depth gauge	Graduation: 0.05mm or 0.02mm, Stainless steel	All
	Screw thread micrometer	Micrometer Type: Screw Thread Micrometer, 14-18 TPI Range (in): 0 - 1" Capacity Pitch Diameter Graduations (in): .001" Anvil/Spindle Material: Steel Anvil Type: Double V-anvil Spindle Type: Pointed spindle	
	Screw pitch gauge	For metric, whitworth and unified threads	

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Manufacturing technology volume 1	P.N. Rao	McGrawHill Education ,2017 ISBN: 978-1259062575
2.	Manufacturing technology volume 2	P.N. Rao	McGraw Hill Education ,2018 ISBN: 978-9353160524,9789353160524
3.	A Textbook of manufacturing Technology-1	Dr. P.C.. Sharma	S. Chand,2011 ISBN:9788211928212
4.	A Textbook of manufacturing Technology-2	Dr. P. C.. Sharma	S. Chand,2013 ISBN:9788211928465
5.	Production technology	R.K Jain	Khana publishers,2021 ISBN:978-8195207565
6.	Manufacturing science	Amitabha Ghosh, Ashok KumarMallik	East-west Press Pvt-Ltd, 2010 ISBN:8176710636

(b) Online Educational Resources:

1. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf
2. https://archive.nptel.ac.in/courses/112/107/112107083/
3. https://nptel.ac.in/courses/112106153
4. https://nptel.ac.in/courses/112107089
5. https://archive.nptel.ac.in/courses/112/105/112105233/
6. http://www.digimat.in/nptel/courses/video/112105233/L13.html
7. https://themechanicalengineering.com/milling-machine/
8. https://www.youtube.com/watch?v=RtGl5hpiT_w

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

(c) Others:

1. Lab Manuals
2. Users' Guide
3. Manufacturers' Manual
4. Learning Packages

******

A) Course Code **: 2425302 (T2425302/S2425302)**

B) Course Title **:** Material Science and Engineering

C) Pre- requisite Course(s) **:** Basic knowledge about metal and non-metal

D) Rationale **:**

Material Science and Engineering is the basic understanding about the internal body structures, defects, properties etc of the ferrous and non-ferrous materials. So, knowledge of their properties and composition is essential. This subject deals with the solidification of metal and alloy, equilibrium diagrams and their application. It covers metrological aspects of metal and alloy such as micro and macroscopic examination of metal and alloy. The subject includes study of iron- iron carbon equilibrium diagrams, TTT diagram, various heat treatment processes .It discusses about failure analysis, different types of destructive testing, corrosion of 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-

CO1- Correlate between the internal structure of materials and their properties

CO2- Interpret equilibrium phase diagrams

CO3- Select relevant Non-Ferrous metal & Anti friction alloy material for the given application

CO4- Use destructive and nondestructive testing method to test the properties of material.

CO5- Select relevant material for the given application.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Board of Study	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				
Mechanical Engineering	**2425302**	Basics Thermodynamics	02	01	-	02	05	04

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Board of Study	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)	
Mechanical Engineering	**2425302**	Basics Thermodynamic	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: T2425302

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1a Analyze the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF (Atomic Packing Factor), Co-ordination Number etc *TSO.1b* Explain various types of bonds with their applications *TSO.1c* Choose the suitable crystalline material for given application. *TSO.1d* Identify the defects in given crystalline materials *TSO.1e* Solve the given problems	**Unit-1.0 Introduction to Engineering Material** 1.1 Classification of materials: metals, ceramics, polymers and composites, Engineering requirements of materials, relevant properties (physical, mechanical, thermal, electrical, chemical), cost; Range of applications; Material designation and standards; Ashby diagrams; Selection criteria and process 1.2 Nature of bonding in materials: metallic, ionic, covalent and mixed bonding; structure of materials: fundamentals of crystallography, symmetry operations, crystal systems, Bravais lattices, unit cells, primitive cells, crystallographic planes and directions; structures of metals, ceramics, polymers, amorphous materials and glasses. 1.3 Defects in crystalline materials- 0-D, 1-D and 2-D defects; vacancies, interstitials, solid solutions in metals and ceramics, Frenkel and Schottky defects-dislocations, grain boundaries, twins, stacking faults; surfaces and interfaces.	**CO1**
TSO 2a. Describe major types of special steels such as HSLA, TRIP, Dual and Tool steels and cast-irons *TSO 2b.* Analyze the phase diagrams to identify the phases present in different alloy systems *TSO 2c.* Explain the structure and properties of given ferrous metals and alloys *TSO 2d.* Select relevant ferrous metal for specific applications. *TSO 2e.* Describe Standard commercial grades of steel as per BIS and AISI *TSO 2f.* Describe the basic terminologies associated with identification of phase diagrams and reactions *TSO 2g.* Solve the given problems	**Unit-2.0 Ferrous Metal & Phase Diagram** 2.1 Ferrous metals and its Alloys, Iron ores – Pig iron: classification, composition and effects of impurities on iron; Cast Iron: classification, composition, properties and uses; Wrought Iron: properties, uses/applications of wrought Iron; comparison of cast iron, wrought iron and mild steel and high carbon steel 2.2 Alloy Steels – purpose of alloying; effects of alloying elements – Important alloy steels: Silicon steel, High Speed Steel (HSS), heat resisting steel, spring steel, Stainless Steel (SS): types of SS, applications of SS – magnet steel – composition, properties and uses 2.3 Standard commercial grades of steel as per BIS and AISI 2.4 Phase diagrams- Gibbs phase rule, Degrees of Freedom, Unary phase diagram, Introduction to Binary phase diagram- Isomorphous system, Eutectic system, Eutectoid system , Iron-Carbon binary diagram, flow sheet for production of iron and steel, Application of phase diagram	**CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.3a Explain the structure and properties of given nonferrous metals and alloys *TSO.3b* Select relevant non-ferrous metal and anti-friction alloy for specific applications *TSO.3c* Correlate the properties of given material with its composition.	**Unit-3.0 Non-Ferrous metal & Anti Friction Alloy** 3.1 Non-ferrous metals and its Alloys - Properties and uses of aluminum, copper, tin, lead, zinc, magnesium and nickel; Copper alloys: Brasses, bronzes – composition, properties and uses; Aluminum alloys: Duralumin, hindalium, magnalium -composition, properties and uses; Nickel alloys: Inconel, monel, nichrome – composition, properties and uses 3.2 Anti-friction/Bearing alloys: Various types of bearing bronzes - Standard commercial grades as per BIS/ASME.	**CO3**
TSO.4a Describe the various factors affecting/causing failures *TSO.4b* Select material for the given problem that can with stand catastrophic failures at different environment. *TSO.4c* Interpret the relationship between stress and strain *TSO.4d* Analyze the yielding behavior and dislocation influence on plastic deformation *TSO.4e* Determine properties of given material using different testing methods. *TSO.4f* Apply corrosion preventive techniques on the given material *TSO.4g* Describe corrosion prevention procedure for the given material. *TSO.4h* Describe coating and surface treatment procedure for the given material. *TSO.4i* Describe various methods to quantify the mechanical integrity of materials and their failure criteria *TSO.4j* Solve the given problems	**Unit-4.0 Destructive Testing and Nondestructive Testing** 4.1 Failure analysis & Testing of Materials - Introduction to failure analysis; Fracture: ductile fracture, brittle fracture; cleavage; notch sensitivity; fatigue; endurance limit; characteristics of fatigue fracture; variables affecting fatigue life; creep; creep curve; creep fracture; 4.2 Destructive testing: Tensile testing; compression testing; Hardness testing: Brinell, Rockwell; bend test; torsion test; fatigue test; creep test. 4.3 Non-destructive testing: Visual Inspection; magnetic particle inspection; liquid penetrant test; ultrasonic inspection; radiography. 4.4 Corrosion of Metal And Alloys- Mechanism of corrosion, types of corrosion, corrosion prevention technique 4.5 Surface engineering processes: Coatings and surface treatments; Cleaning and mechanical finishing of surfaces; Organic coatings; Electroplating and Special metallic plating	**CO4**
TSO.5a Select relevant material for the given problem. *TSO.5b* Evaluate the properties of given materials *TSO.5c* Identify the material from the given properties *TSO.5d* Use advanced material as per the given situation	**Unit-5.0 Advanced Material** 5.1 Polymers – Classification and applications; Polymerization techniques 5.2 Ceramics – Oxide ceramics, ceramic insulators, bio-ceramics and Glasses 5.3 Composites –Reinforcement, matrix, metal matrix composites, ceramic composites, polymer composites 5.4 Biomaterials, optical materials, high temperature materials, energy materials, and nanomaterials 5.5 Conducting and resisting materials – types, properties and applications; 5.6 Semiconducting materials – properties and applications; 5.7 Magnetic materials – Soft and hard magnetic materials and applications	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	5.8 Superconductors and dielectric materials – properties and applications 5.9 Smart materials-Piezoelectric, magnetostrictive and electrostrictive materials.	

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: S2425302** 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.

- Calculate phase % of given binary alloy using tie line rule and lever rule.
- Draw atomic structures of substitutional solid solution.
- Prepare chart for different grain size structure.
- Prepare color diagram using drawing sheet of any one binary alloy

b. Micro project:

- Prepare the model representing BCC/FCC/HCP structure of a given metal using balls and adhesive materials
- Collect 05 ductile and brittle material and determine the fracture characteristics and submit a detail report including Analysis of the output.
- Determine the micro-structure of Cast Iron, Mild Steel, Brass Solder under, Annealed, Cold Worked, forged/rolled conditions and submit a detail report

c. Other Activities:

1. Seminar Topics:
   - Smart materials
   - Destructive and nondestructive testing
   - Surface coating and plating

2. Visits:
   - Visit nearby steel plant and prepare a detail report on the destructive and nondestructive methods used for testing and on basis of given criteria
   - Visit nearby advanced material lab and prepare a detail report on the advanced machines and equipment's with specification used for testing of ferrous, nonferrous, and advanced material.
3. Self-learning topics:
   - Standard commercial grades of steel as per BIS and AISI
   - Metallography
   - Material characterization

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

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

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Engineering Material	8	CO1	13	4	4	5
Unit-2.0 Ferrous Metal & Phase Diagram	10	CO2	15	4	5	6
Unit-3.0 Non-Ferrous Metal & Anti Friction Alloy	10	CO3	14	4	4	6
Unit-4.0 Destructive Testing and Nondestructive Testing	12	CO4	16	4	5	7
Unit-5.0 Advanced Material	8	CO5	12	4	4	4
Total	**48**	**-**	**70**	**20**	**22**	**28**

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

O) Suggested Assessment Table for Laboratory (Practical): (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.	Foundations of Materials Science and Engineering	William F. Smith Javad Hashemi Dr. Francisco Presuel-Moreno	McGraw Hill, 2022 ISBN-10 : 9355322178 ISBN-13 : 978-9355322173
2.	Callister's Materials Science and Engineering,	William D. Callister Jr. David G. Rethwisch	Wiley, 10th edition, 2020 ISBN-10 : 1119453917 ISBN-13 : 978-1119453918
3.	Introduction to Materials Science for Engineers, 8e Paperback – 15 March 2020 by (Author)	James F. Shackelford	Pearson Education; 8th edition, 2020 ISBN-10 : 9353941393 ISBN-13 : 978-9353941390
4.	Kinetics in Materials Science and Engineering	Dennis W. Readey	CRC Press, 2019 ISBN-10 : 0367869837 ISBN-13 : 978-036786983
5.	Materials Science and Engineering: Problems with Solutions	Shetty M.N	PHI Learning Private Limited ,2016 ISBN-10 : 8120351096 ISBN-13 : 978-8120351097
6.	Mechanical Behavior of Materials	William F. Hosford	Cambridge University Press; 2nd edition, 2009 ISBN-10 : 0521195691 ISBN-13 : 978-0521195690

(b) Online Educational Resources:

1. www.sakshat.ac.in/
2. www.ironcarbondigram.com/
3. www.substech.com/dokuwiki/doku.php?id=iron-carbon_phase_diagram
4. http://vimeo.com/32224002
5. http://nptel.ac.in/courses/113105024/
6. https://www.smartzworld.com/notes/metallurgy-materials-science-notes-pdfmms/
7. http://www.uom.ac.mu/faculties/foe/mped/students_corner/notes/enggmaterials/lecturenotes.pdf

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. Conference paper
2. Journal paper
3. Lab Manuals

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A) Course Code : **2425303 (T2425303/P2425303/S2425303)**

B) Course Title : Strength of Materials for Mechanical Engg. (ME, ME (Auto))

C) Pre- requisite Course(s) : Physics, Engineering Mechanics

D) Rationale :

The effects due to action of force system on a body have already been studied in Physics/Mechanics in previous Semester/Class. Generally, Mechanical/Automobile Engineering components and members are subjected to different loading conditions, resulting into different types of stresses and strains. In this course, estimation of induced stresses and strains of determinate structures/components under action of these transverse, axial, thermal, shear loads, pressure, bending and torsion moment are performed. Moreover, this course will lay sound foundation for analysis and design of mechanical components going to be discussed in latter semesters.

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** Calculate direct stresses and strains in Mechanical members/components in single load situations.
- **CO-2** Determine bending moment, shear force, slope and deflection in different types of beams/components subjected to transverse loading
- **CO-3** Calculate bending and shear stresses in different types of beams/components.
- **CO-4** Estimate shear stresses in shafts subjected to twisting moment.
- **CO-5** Calculate Stresses and deflection in helical springs.
- **CO-6** Calculate various stresses in thin pressure vessels.
- **CO-7** Calculate principal stress and strain in machine members subjected to multi-load situations.

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	-	3	2	-	1		
CO-2	3	2	-	2	-	-	1		
CO-3	3	2	-	2	-	-	1		
CO-4	3	2	-	2	-	-	1		
CO-5	3	2	-	2	-	-	1		
CO-6	3	2	-	-	-		1		
CO-7	3	2	-	-	-		1		

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

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

G) Teaching & Learning Scheme:

Board of Study	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				
Mechanical Engineering	**2425303**	Strength of Materials for Mechanical Engg.	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:

Board of Study	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)	
Mechanical Engineering	**2425303**	Strength of Materials for Mechanical Engg.	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: T2425303

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Identify various types of loadings in the given component/member with justification. *TSO 1b.* Identify mechanical components subjected to single load situations. *TSO 1c.* Calculate various elastic moduli in the given situation. *TSO 1d.* Calculate direct stresses and strains in the given determinate component/member subjected to single static longitudinal, shear and thermal loads.	**Unit-1.0 Direct Stresses and Strains in Components** 1.1 Different types of Loads. 1.2 Mechanical properties of materials like Strength, Stiffness, Hardness, Toughness, Ductility, Malleability, Elasticity, Plasticity. 1.3 Statically Determinate structures. 1.4 Direct Stress, Linear Strain, Hook's Law, Stress-Strain curve of ferrous and non ferrous materials, Modulus of Elasticity, Yield, Proof, Breaking and Ultimate Stress and Factor of safety. 1.5 Lateral Strain and Poisson's ratio, Relations between different Moduli. 1.6 Temperature Stresses and Strain with and without yielding. 1.7 Shear Stress, Shear Strain and Shear Modulus. 1.8 Bulk Modulus and Volumetric Strain	**CO1**
TSO 1e. Identify Mechanical components subjected to bending moment. *TSO 2a.* Draw Shear Force and Bending Moment Diagram for the given Statically Determinate Beam. *TSO 2b.* Identify location of point of contra flexure in the given situation with justification. *TSO 2c.* Determine deflection and slope in a given Statically determinate Beam using given method.	**Unit-2.0 Shear Force, Bending Moment, Slope and Deflection in Beam type Components** 2.1 Types of Beams like Cantilever, Simply Supported and Over Hang Beams. 2.2 Relation between Shear Force and Bending Moment. 2.3 Sagging and Hogging Bending Moment and its importance. 2.4 Point of Contra flexure and its importance. 2.5 S.F and B.M Diagram for Cantilever, Simply Supported and Over Hang Beams. 2.6 Slope and Deflection in Cantilever and Simply Supported beams.	**CO2**
TSO 3a. Calculate the bending stress in the given beam. *TSO 3b.* Calculate Slope and Deflection in the given beam. *TSO 3c.* Calulate the shear stress behavior in the given beam.	**Unit-3.0 Bending and Shear Stresses in Beam type Components** 3.1 Bending Theory, Flexural equation, Bending stress, Bending strain, Sectional Modulus 3.2 Neutral Axis, application of Bending theory to Statically determinate beams. 3.3 Shear stress: Average and Maximum shear stress for rectangular and circular section beams. 3.4 Short members subjected to eccentric loading.	**CO3**
TSO 4a. Calculate the shear stresses in the given shaft which is subjected to pure twisting moment.	**Unit-4.0 Torsion of Shaft** 4.1 Torsion/Twisting Moment, Torsional Equation, Angle of Twist, Polar Moment of Inertia,	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 4b. Calculate angle of twist and shear train in given solid shaft. *TSO 4c.* Calculate the power transmitted by the given solid and hollow shafts. *TSO 4d.* Select solid and hollow shaft for the given application with justification.	Torsional Rigidity. 4.2 Torsional Stress and Strain in solid and hollow shafts. Comparison between Solid and Hollow Shafts subjected to pure torsion. 4.3 Power Transmitted /Consumed for shaft, spindle and axle of solid and hollow sections subjected to Twisting Moment.	
TSO 5a. Calculate Stiffness, deflection and maximum stress in the given spring. *TSO 5b.* Estimate strain energy for the given axially loaded helical spring.	**Unit-5.0 Stresses and Deflection in Helical Springs** 5.1 Definition, types and application of springs. 5.2 Spring classification based on size, shape and load-leaf spring, helical and spiral spring. 5.3 Stiffness, deflection and maximum stress in helical open and closed coil springs only.	**CO5**
TSO 6a. Identify mechanical components subjected to internal/external pressure loading. *TSO 6b.* Find out various stresses induced in the given thin pressure vessel due to internal/external pressure.	**Unit-6.0 Thin Cylindrical and Spherical Pressure Vessels** 6.1 Pressure Vessels. 6.2 Thin cylinders and spheres subjected to internal pressure; Hoop stresses, longitudinal stress and change in volume. 6.3 Wire bound thin Cylindrical pressure vessels.	**CO6**
TSO 7a. Identify multi-load situations with justifications. *TSO 7b.* Estimate principal stresses and maximum shear stress for a given combined loading by analytical Approach. *TSO 7c.* Estimate principal stresses and maximum shear stress for a given combined loading by Mohr's circle method.	**Unit-7.0 Principal Stresses** 7.1 Multi load situations and need of estimating principal stresses. 7.2 Definition of principal plane and principal stresses. 7.3 Expression for normal and tangential stress, maximum shear stress. 7.4 Stresses on inclined planes. 7.5 Position of principal planes and planes of maximum shear. 7.6 Graphical solution using Mohr's circle of Stresses.	**CO7**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2425303

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use UTM to perform Tensile test. *LSO 1.2.* Plot stress-strain curve for a given material under tensile loading. *LSO 1.3.* Estimate yield strength, proof stress, ultimate strength, percentage elongation in length, percentage reduction in area. *LSO 1.4.* Use related IS Code	1.	Perform Tension Test on Mild Steel/ Aluminium on Universal Testing machine as per IS432 (I)	**CO1**
LSO 2.1. Use UTM to perform Compression test. *LSO 2.2.* Plot stress-strain curve for a given material under compressive loading. *LSO 2.3.* Estimate yield strength, proof stress, ultimate strength, percentage elongation in length, percentage reduction in area.	2.	Perform Compression test on Cast Iron on Universal Testing Machine as per IS 14858	**CO1**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 2.4. Use related IS Code			
LSO 3.1. Use UTM to perform Shear test. *LSO 3.2.* Plot stress-strain curve for a given material under shear loading. *LSO 3.3.* Estimate corresponding yield strength, proof stress, and ultimate strength. *LSO 3.4.* Use related IS Code	3.	Perform direct Shear Test on Mild Steel using Universal Testing Machine as per IS 5242	**CO1**
LSO 4.1. Identify simply supported end conditions *LSO 4.2.* Correlate Young's Modulus of beam material with deflection and area moment of inertia.	4.	Determine Young's Modulus of Elasticity of different materials' beam simply supported at ends.	**CO1, CO2**
LSO 5.1. Use Impact machine under Izod and Charpy test situations *LSO 5.2.* Identify way to apply impact loading *LSO 5.3.* Estimate Toughness of the specimen material. *LSO 5.4.* Use related IS Code	5.	Calculate Impact Value/Toughness of Mild Steel and Aluminium using Izod and Charpy Impact Test Apparatus as per IS 1757.	**CO1**
LSO 6.1. Use Brinell, Rockwell and Vicker's hardness testers. *LSO 6.2.* Perform hardness test. *LSO 6.3.* Correlation of different hardness values from different tests.	6.	Perform Brinell, Rockwell and Vicker's hardness test on different metals.	**CO1**
LSO 7.1. Use Combined Shear Force and Bending Moment apparatus. *LSO 7.2.* Estimate Bending moment and shear force in beams. *LSO 7.3.* Estimate the point of contraflexure.	7.	Estimate Maximum Bending moment and Shear force for simply supported and cantilever beams under point load and UDL using 'Combined Shear Force and Bending Moment' apparatus.	**CO2**
LSO 8.1. Use using 'Slope and Deflection' apparatus *LSO 8.2.* Find out Measure flexural rigidity (EI) for a given beam *LSO 8.3.* Correlate experimental and analytical values	8.	Measure flexural rigidity (EI) for beam using 'Slope and Deflection' apparatus and compare it with theoretical value.	**CO2**
LSO 9.1. Use using 'Slope and Deflection' apparatus *LSO 9.2.* Investigate the effect of beam length and width on deflection of beam *LSO 9.3.* Correlate experimental and analytical values	9.	Investigate the effect of beam length and width on deflection of beam and compare it with theoretical value using 'Slope and Deflection' apparatus.	**CO2**
LSO 10.1. 'Torsion of Bar' apparatus *LSO 10.2.* Correlate the angle of twist, length and modulus of Rigidity of a shaft. *LSO 10.3.* Use related IS Code	10.	Perform the torsion test on wire/ Rod of different materials using 'Torsion of Bar' apparatus. (Part I) as per IS 1717	**CO4**
LSO 11.1. Use 'Extension and compression of Spring 'apparatus *LSO 11.2.* Estimate Stiffness of the given spring. *LSO 11.3.* Correlate the effect of spring deflection and load on strain energy stored.	11.	Measure Stiffness and deflection of given spring and Modulus of Rigidity of the spring wire using 'Extension and compression of Spring 'apparatus.	**CO5**

L) **Suggested Term Work and Self Learning: S2425303** 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.

- Collect information about the values of different engineering properties of five standard mechanical engineering materials and present in tabular form.
- Identify simple mechanical components where single load situation exist.
- Solve numerical problems related to direct stresses and strains.
- List out different types of test that can be performed on a UTM.
- Solve numerical problems related to S.F and B.M Diagram for Cantilever, Simply Supported and Over Hang Beams type components.
- Collect information comprising of different mechanical components subjected to bending stresses.
- Prepare a list of machine components where deflection is desirable and non desirable for the functioning.
- Solve problems related to deflection of components under transverse loading.
- Solve numerical problems on simple multi load situations.

b. Micro Projects:

1. Prepare a model showing the effects of thermal stresses on prismatic components.
2. Prepare an excel sheet to calculate SF and BM in a simply supported beam and cantilever beam.
3. Prepare a working model to measure deflection in digital form using sensors/potentiometer/transducers of a cantilever beam with facility to vary the position of a point load.
4. Perform internet search to prepare a list of software used to draw and estimate shear force, bending moment and deflection of beams.
5. Prepare a model of a shaft to demonstrate relation between length and angle of twist.
6. Collect data of three shafts of three different electric motors available in your college like length, diameter and material. Note down the power and speed of the motor and comment on the shaft diameters used.

c. Other Activities:

1. Seminar Topics:
    - Different mechanical property testing methods used in industry
    - Different types of beams with examples
    - Relation between Load, SF, BM, Slope and Deflection
    - Application of solid and hollow shafts.
    - Different types of Helical springs
    - Domestic and industrial Thin and Thick pressure vessels

2. Visits:
    - Visit a nearby industry/workshop to identify and list the various failures in machine components due to direct stresses.
    - Visit to automobile service center and tabulate the usage of helical/leaf spring in various automotives Cars/Trucks/Buses.
    - Visit institute mechanical workshop and list shafts and their applications in different machines and equipment.

3. Self-learning topics:
    - Relations between different elastic moduli
    - Spherical Pressure vessels
    - Deflection in Cantilever beams with point and Uniform Distributed Loads
    - Power transmitted by a hollow shaft.
    -

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%	-	17%	50%	20%
CO-2	10%	10%	10%	33%	17%	20%	20%
CO-3	15%	15%	15%	33%	17%	-	20%
CO-4	15%	15%	15%	34%	17%	15%	20%
CO-5	10%	10%	10%	-	17%	15%	20%
CO-6	10%	10%	10%	-	15%	-	-
CO-7	20%	20%	20%	-	-	-	-
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Direct Stresses and Strains in components	10	CO1	14	3	5	6
Unit-2.0 Shear Force, Bending Moment, Slope and Deflection in Beam type components	10	CO2	12	3	3	6
Unit-3.0 Bending and Shear stresses in beam type components	08	CO3	10	3	2	5
Unit-4.0 Torsion of Shaft	06	CO4	10	3	2	5
Unit-5.0 Stresses and Deflection in Helical Springs	04	CO5	08	3	0	5
Unit-6.0 Thin Cylindrical and Spherical Pressure Vessels	04	CO6	08	3	0	5
Unit-7.0 Principal Stresses	06	CO7	08	2	0	6
Total	**48**	**-**	**70**	**20**	**12**	**38**

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.	Perform Tension Test on Mild Steel/ Aluminium on Universal Testing machine as per IS432 (I)	CO1	40	50	10
2.	Perform Compression test on Cast Iron on Universal Testing Machine as per IS 14858	CO1	40	50	10
3.	Perform direct Shear Test on Mild Steel using Universal Testing Machine as per IS 5242	CO1	40	50	10
4.	Determine Young's Modulus of Elasticity of different materials' beam simply supported at ends.	CO1, CO2	40	50	10
5.	Calculate Impact Value/Toughness of Mild Steel and Aluminium using Izod and Charpy Impact Test Apparatus as per IS 1757.	CO1	40	50	10
6.	Perform Brinell, Rockwell and Vicker's hardness test on different metals.	CO1	40	50	10
7.	Estimate Maximum Bending moment and Shear force for simply supported and cantilever beams under point load and UDL using 'Combined Shear Force and Bending Moment' apparatus.	CO2	40	50	10
8.	Measure flexural rigidity (EI) for beam using 'Slope and Deflection' apparatus and compare it with theoretical value.	CO2	40	50	10
9.	Investigate the effect of beam length and width on deflection of beam and compare it with theoretical value using 'Slope and Deflection' apparatus.	CO2	40	50	10
10.	Perform the torsion test on wire/ Rod of different materials using 'Torsion of Bar' apparatus. (Part I) as per IS 1717	CO4	40	50	10
11.	Measure Stiffness and deflection of given spring and Modulus of Rigidity of the spring wire using 'Extension and compression of Spring 'apparatus.	CO5	40	50	10

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

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

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

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

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Universal Testing Machine	**Universal Testing Machine:** Capacity - 40 tones. Type: Mechanical type digital, electrically Operated. Accessories: (1) Tensile test attachment for flat and round specimen up to32 mm. (2) Compression test attachment(3)Shear test attachment with sizes of bushes (3) Shear test attachment (4) Two point and three pont bending attachment etc.	1,2,3,4,5

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
2.	Impact Testing Machine (Izod Test)	**IZOD Impact Test Apparatus:** Pendulum dropangle:90°-120; Pendulum effective Wt:20-25kg; Striking velocity of pendulum:3-4 m/sec; Pendulum impact energy:168 joule; Min scale graduation:2 Joule.	5
3.	Impact Testing Machine (Charpy Test)	**CHARPY Test Apparatus:** Pendulum drop angle140°; Pendulum effective Wt 20-25 kg; Strikingvelocityofpendulum5-6m/sec; Pendulum impact energy 300 j; Min scale graduation 2 J; Distance of axis of pendulum rotation from center of specimen to specimen hit by pendulum 815mm.	5
4.	Perform Brinell, Rockwell and Vicker's hardness testers		6
5.	Combined Shear Force and Bending Moment apparatus	Combined Shear Force and Bending Moment apparatus	7
6.	Slope and Deflection of Beam Apparatus	A bench mounted apparatus with a steel base with support at ends. The supports can be fitted with knife edges or clamp plates.A steel beam and two load hangers are together with two dial gauges for measuring beam deflections and slopes, Micrometer, Calipers, Scale, Weights and hanger.	8, 9
7.	Torsion Testing Machine	**Torsion Testing Machine:** Fixed with auto torque select or to regulate torque ranges Contains geared motor to apply torque to specimen through gearbox Attached with autographic recorder for relation between torque and angle of twist Accuracy +1% of the true torque Suitable for: Torsion and Twist test on diverse metal rods and flats, Torque Measurement by pendulum dynamometer system	10
8.	Torsions of bars apparatus	**Torsions of bars apparatus:** To understand and investigate directly the relationship between the torsional load applied to a round bar and the angular twist produced and how this relationship varies with the beam material and its cross-sectional polar moment of area. Specimens are rigidly held in a clamp fixed to one end of the bench top base frame of the apparatus.	10
9.	Extension and compression of Springs apparatus	The apparatus should be designed to be mounted on a rigid vertical support approximately 1.5 metres above floor level. It is used to test tension springs up to 200 mm in length. The maximum spring diameter is 38mm, Micrometer, Calipers, Scale, Weights and hanger.	11

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Strength of Materials	R.K. Rajput	S. Chand Publishing (6th Edition, 2015, ISBN-13: 978-9385401367
2.	Strength of Materials	Rattan S.S.	McGraw Hill Education; Third edition, 2016, ISBN-13: 978-9385965517
3.	Strength of Material and Mechanics of Structures	B.C. Punamia	Laxmi Publications (p) Ltd. New Delhi, 10/e, 2015, ISBN-13:978-8131809259
4.	Strength of Material	S. Ramamurutham	Dhanpat Rai Publishing Company Private Limited-New Delhi; Eighth edition, 2014, ISBN-13:978- 9384378264

(b) Online Educational Resources:

1. nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024.htm
2. https://onlinecourses.nptel.ac.in/noc19_ce18/preview
3. https://www.coursera.org/learn/mechanics-1
4. https://www.coursera.org/courses?query=mechanics%20of%20materials
5. en.wikipedia.org/wiki/Shear_and_moment_diagram
6. www.freestudy.co.uk/mech%20prin%20h2/stress.pdf
7. www.engineerstudent.co.uk/stress_and_strain.html
8. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf

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

(c) Others:

1. Lab Manuals
2. Users' Guide
3. Manufacturers' Manual
4. Learning Packages

******

A) Course Code **: 2425304 (T2425304/P2425304/S2425304)**

B) Course Title **:** Basics Thermodynamics (ME, ME (Auto))

C) Pre- requisite Course(s) **:**

D) Rationale **:**

Thermodynamics is a branch of science that deals with energy transformations and are primarily concerned with the two forms of energy heat and work. The energy transformations are governed by the various laws of thermodynamics known as zero, first, second and third laws. Applications of thermodynamics can be found in fields of refrigeration and air-conditioning to automobile. Its principles are used to design automobile engines, steam turbines, power plants, HVAC, aircraft and rockets, etc. Thus, every student of Diploma Mechanical Engineering should have a fundamental knowledge of this course.

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 Asses' thermodynamic properties and systems.
CO-2 Apply the laws of thermodynamics to the given systems**.**
CO-3 Analyze thermodynamics cycles
CO-4 Quantify the behavior of boiler based on the thermodynamic cycle**.**
CO-5 Analyze processes involving ideal gases and real substances

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/ Developmentof 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	3	-	-	-	-		
CO-2	3	3	2	2	1	2	2		
CO-3	3	3	2	2	2	-	2		
CO-4	3	2	2	2	-	-	-		
CO-5	3	3	2	2	2	2	2		

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

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

G) Teaching & Learning Scheme:

Board of Study	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				
Mechanical Engineering	**2425304**	Basics Thermodynamics	02	01	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:

Board of Study	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)	
Mechanical Engineering	**2425304**	Basics Thermodynamic	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:

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: T2425304

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain thermodynamics & various thermodynamics processes. *TSO 1b.* Analyze heat and work. *TSO 1c.* Draw P-V and T-S diagram of different process. *TSO 1d.* Calculate internal energy and enthalpy. *TSO 1e.* Identify state through properties. *TSO 1f.* Calculate the work done by a closed system *TSO 1g.* Calculate changes in entropy using thermodynamic tables *TSO 1h.* Calculate changes in entropy for ideal gases *TSO 1i.* calculate absolute and gage pressure, and absolute temperature. *TSO 1j.* calculate changes in kinetic, potential, enthalpy and internal energy.	**Unit-1.0 Fundamental Concepts of Thermodynamics** 1.1 Thermodynamics: Terminology, definition and scope, microscopic and macroscopic approaches, Basic concepts of – State, state point, System, Boundary and Surroundings, 1.2 Identification of a state through properties Thermodynamic properties, their units and classifications. intensive and extensive various property diagrams 1.2 Mechanics definition of work and its limitations, Heat and work, Work done, sign convention, change in internal energy, change in enthalpy and entropy, Specific heats at constant volume and at constant pressure. 1.3 Thermodynamic processes of ideal gases. Isobaric, Isochoric, Isothermal, Adiabatic and polytropic with representation on P-V and T-S diagram. 1.4 General gas equation, Characteristics of gas constant, Mol of gas, Universal gas constant, specific heats of ideal gases. 1.5 Thermodynamic equilibrium, Reversibility and irreversibility, Quasi-static process	**CO1**
TSO 2a. Apply zeroth law of thermodynamics to a given thermodynamic system. *TSO 2b.* Apply first law of thermodynamics to a given thermodynamic system. *TSO 2c.* Calculate thermal efficiency & C.O.P. for a given thermodynamic cycle *TSO 2d.* Apply third law of thermodynamics to a given thermodynamic system *TSO 2e.* Explain Steady flow energy equation and their application *TSO 2f.* Apply second law of thermodynamics to a given thermodynamic system *TSO 2g.* Analyze systems and control volumes through the application of the second law	**Unit-2.0 Law of Thermodynamics** 2.1 Zeroth and first law of thermodynamics, Statement of the First law of thermodynamics for a cycle Steady flow energy equation and their application. 2.2 Derivation of the First law of processes, energy, internal energy as a property 2.3 Concept of heat source and heat sink, heat reservoir, heat engine, heat pump and refrigerator 2.4 Statement of the second law of thermodynamics: - Kelvin Planck Statement, Clausius Statement and their equivalence, heat engine, heat pump, refrigerator and simple numerical on thermal efficiency and COP. 2.5 Statement of the third law of thermodynamic	**CO2**
TSO 3a. Describe types of thermodynamics cycle. *TSO 3b.* Draw P-V and T-S diagram of Carnot cycle *TSO 3c.* Calculate thermal efficiency of Carnot cycle. *TSO 3d.* Draw P-V and T-S diagram of cycle and Brayton cycle. *TSO 3e.* Calculate air standard efficiency of different cycle	**Unit-3.0 Thermodynamic Cycles** 3.1 Classifications of thermodynamic cycle. 3.2 Carnot cycle and its representation on P-V and T-S diagram. 3.3 Derivation of thermal efficiency of Carnot cycle and simple numerical based on it.	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3f. Analyze the Carnot, Otto, and Rankine thermodynamic cycles.	3.4 Concept of air standard efficiency of Otto, Diesel, and Brayton cycle (Without derivation), representation on P-V & T-S diagram.	
TSO 4a. Describe steam and their phases. *TSO 4b.* Calculate dryness fraction and degree of superheat. *TSO 4c.* Calculate enthalpy of steam using steam table. *TSO 4d.* Explain given type of boiler, mountings and their accessories. *TSO 4e.* Identify different components of given boiler	**Unit-4.0 Properties of Steam and Steam Power** 4.1 Formation of steam, various phases like wet steam, dry saturated Steam, superheated steam. 4.2 Dryness fraction, degree of superheat, sensible heat, Latent heat, calculation of enthalpy of wet, dry saturated & superheated steam using steam table. 4.3 Steam boilers: Classification, Construction and working of Cochran, Babcock and Wilcox, Lamont and Loeffler boiler. Mountings – Bourdon Pressure Gauge, Safety valves, Water level Indicator and fusible Plug. Accessories – Economizer, super heater and air pre-heater.	**CO4**
TSO.5a Sketch P-v, T-v, and P-T plots for steam, R-134a, and ideal gases. *TSO.5b* Locate data states on P-v, T-v, and P-T plots for steam, R-134a, and ideal gases *TSO.5c* Apply the concept of the generalized compressibility factor to determine the state of a gas *TSO.5d* Apply the ideal gas equation to solve problems involving pressure, temperature, and volume of ideal gases *TSO.5e* Analyze processes involving ideal gases and real substances as working fluids in both closed systems and open systems *TSO.5f* Determine the properties of pure substances using thermodynamic tables *TSO.5g* Calculate changes in entropy using thermodynamic tables. *TSO.5h* Calculate changes in entropy for ideal gases	**Unit-5.0 Pure Substances, Ideal & Real Gases** **Ideal and perfect gases** 5.1 Differences between perfect, ideal and real gases, equation of state, evaluation of properties of perfect and ideal gases. 5.2 Real Gases: Introduction. Vander Waal's Equation of state, Van der Waal's constants in terms of critical properties, law of corresponding states, compressibility factor, compressibility chart **Pure Substances** 5.3 Definition of a pure substance, phase of a substance, triple point and critical points, sub-cooled liquid, saturated liquid, vapor pressure, two-phase mixture of liquid and vapor, saturated vapor and superheated vapor states of a pure substance 5.4 Representation of pure substance properties on p-T and p-V diagrams, detailed treatment of properties of steam for industrial and scientific use	**CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2425304

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use of thermometer and pressure gauge.	1.	Calibrate thermometers and pressure gauges	CO1
	2.	Compare the accuracy and characteristics response of the different types of thermometers.	CO1
	3.	Determine the pressure with a bourdon tube pressure gauge	CO1
	4.	Determine the pressure with different pressure measuring devices and then compare the measured values	CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 2.1. Use working models of petrol engine/ diesel engine	5.	Use model of cross-sectional view of given petrol engine to identify different parts and components of the engine	CO2
	6.	Use model of cross-sectional view of given diesel engine to identify different parts and components of the engine	CO2
LSO 2.2. Use heat pump	7.	Determine the power input, power output as well coefficient of performance of heat pump	CO2
LSO 2.3. Use steam turbine	8.	Operate impulse and reaction steam turbines.	CO2
	9.	Determine power output & efficiency of a steam turbine	CO2
	10.	Determination of steam flow rate of a steam turbine	CO2
LSO 2.4. Use condenser	11.	Find the efficiency of the given condenser	CO2
LSO 3.1. Use steam engine	12.	Determine the brake power of a single cylinder steam engine with varying load	CO3
LSO 3.2. Use heat Engine	13.	Investigate the first law and Second law of thermodynamic using heat Engine	CO3
LSO 4.1. Use separating and throttling calorimeter	14.	Find dryness fraction of steam by separating and throttling calorimeter.	CO4
LSO 4.2. Use working models of different types of boilers.	15.	Identify low pressure boilers and their accessories and mountings.	CO4
	16.	Identify high pressure boilers and their accessories and mountings.	CO4
	17.	Prepare heat balance sheet for given boiler.	CO4
	18.	Investigate the relationship between pressure and temperature of saturated steam.	CO4
	19.	Carry out fault finding on Boiler control demonstration unit.	CO4
LSO 4.3. Use air-Water-Steam Heat Exchanger	20.	Determine the mean temperature difference between two mediums in both contra and parallel flow using air-Water-Steam Heat Exchanger	CO5
	21.	Plot the temperature difference curves for a variety of flow conditions using air-Water-Steam Heat Exchanger	CO5
LSO 4.4. Use indicator unit	22.	Use indicator unit to draw the PV diagram of a piston side and piston rod side.	CO5

L) Suggested Term Work and Self Learning: S2425304 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.

- Draw P-V and T-S diagram of dual cycle.
- Derive formula of thermal efficiency of otto cycle.

- Differentiate between diesel cycle and otto cycle on the basis of compression ratio and same higher pressure.
- Differentiate between water tube boiler and fire tube boiler on basis of pressure.

b. Micro project:

- Prepare report on different thermal equipment in your home where law of thermodynamics is applicable.
- Prepare report on application of boiler principle equipment like pressure cooker, geyser etc.
- Prepare report on effect of compression ratio on Otto and Diesel cycle.
- Prepare model of boiler mounting and accessories.

c. Other Activities:

1. Seminar Topics:
   - Heat engine
   - Steam Boiler
   - Heat exchanger

2. Visits:
   - Visit nearby thermal power plant and prepare a detail report on the basis of given criteria
   - Visit nearby automobile service station and prepare a detail report on the basis of given criteria.

3. Self-learning topics:
   - Properties of a System
   - Heat pumps
   - Entropy
   - Enthalpy

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

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

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

Note:

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

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

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Fundamental Concepts of Thermodynamics	8	CO1	12	4	4	4
Unit-2.0 Law of Thermodynamics	9	CO2	15	4	5	6
Unit-3.0 Thermodynamic cycles	10	CO3	15	4	5	6
Unit-4.0 Properties of Steam and Steam Power	12	CO4	15	4	5	6
Unit-5.0 Pure Substances, Ideal & Real Gases	9	CO5	13	4	4	5
Total	**48**	**-**	**70**	**20**	**23**	**27**

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.	Calibrate of Thermometers and pressure gauges	CO1	30	60	10
2.	Compare the accuracy and characteristics response of the different types of thermometers.	CO1	40	50	10
3.	Determine the pressure with a bourdon tube pressure gauge	CO1	40	50	10
4.	Determine the pressure with different pressure measuring devices and then compare the measured values	CO1	40	50	10
5.	Use model of cross-sectional view of given petrol engine to identify different parts and components of the engine	CO2	30	60	10
6.	Use model of cross-sectional view of given diesel engine to identify different parts and components of the engine	CO2	40	50	10
7.	Determine the power input, power output as well coefficient of performance of heat pump	CO2	40	50	10
8.	Operate impulse and reaction steam turbines.	CO2	40	50	10
9.	Determine power output & efficiency of a steam turbine	CO2	40	50	10
10.	Determination of steam flow rate of a steam turbine	CO2	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
11.	Find the efficiency of the given condenser	CO2	40	50	10
12.	Determine the brake power of a single cylinder steam engine with varying load	CO3	40	50	10
13.	Investigate the first law and Second law of thermodynamic using heat Engine	CO3	40	50	10
14.	Find dryness fraction of steam by using separating and throttling calorimeter.	CO4	40	50	10
15.	Identify low pressure boilers and their accessories and mountings.	CO4	40	50	10
16.	Identify high pressure boilers and their accessories and mountings.	CO4	40	50	10
17.	Prepare heat balance sheet for given boiler.	CO4	40	50	10
18.	Investigate the relationship between pressure and temperature of saturated steam.	CO4	40	50	10
19.	Carry out fault finding on Boiler control demonstration unit.	CO4	40	50	10
20.	Determine the mean temperature difference between two mediums in both contra and parallel flow using air-Water-Steam Heat Exchanger	CO5	40	50	10
21.	Plot the temperature difference curves for a variety of flow conditions using air-Water-Steam Heat Exchanger	CO5	40	50	10
22.	Use indicator unit to draw the PV diagram of a piston side and piston rod side.	CO5	40	50	10

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

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

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

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

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Thermometer and pressure gauges of different types	300 mm (+10% variation is acceptable). Length of main scale: 180mm±10% Scale smallest division: shall not be more than 0.5 degree centigrade. Bulb length: Shall not be less than 10mm and shall not greater than 25mm. Stem diameter: Shall not be less than 5.5mm and shall not greater than 8mm.	1-4

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
2.	Petrol engine	Single cylinder, 4 stroke, air cooled ,110 cc, fuel-petrol Computerized Engine Test Rigs	5
3.	Diesel engine	Single cylinder, 4 stroke, air cooled ,110 cc, fuel-diesel Computerized Engine Test Rigs	6
4.	Heat pump	Heat pump should have 60° C to 70° C hot water COP of at least 3.6 at 15°C wet bulb ambient, air to water type to heat water to a constant 60°C at condensing temperature at or below 55°C, robust casing manufactured from 304 or 316 stainless steel, The heat pump unit shall be complete with independent compressor circuit where more than one (1) compressor is utilized, evaporation coil shall be aluminum on copper tube, axial fans, primary water circulation pump, check valves, gate valves, gauges and automatic control system Heat pump should be a 3PH, 380V, 36KW	7
5.	Steam turbine	Steam Turbine Test Rig	8,9,10
6.	Condenser	Working models of Jet condenser, Surface condenser	11
7.	Steam engine	Working models Steam engine	12
8.	Heat Engine	Working models Heat Engine	13
9.	Separating and throttling calorimeter	Separating Calorimeter: lagged with glass wool and cladded with aluminum and should have gauge column, pressure gauge, stop cock & needle valve Throttling Calorimeter: lagged with glass wool and cladded with aluminum, brass orifice and should have cased thermometer, manometer, valve, etc. Boiler Unit- mini boiler unit approx. 5ltr capacity producing steam of 2 -4 kg max. fitted with 2kW heater, Pressure gauge, safety valve and glass tube water level indicator.	14
10.	Different types of Boilers	Working model of Cochran, Lancashire Boiler, Babcock & Wilcox Boiler	15-19
11.	Boiler mounting and accessories	Working models of water level indicator, safety valve Fusible plug, pressure gauge, stop valve, feed check valve, 7. blow off cock, manhole and mud box Accessories- super heater, economizer, air preheater	15-19
12.	Heat Exchanger	Shell & tube heat exchanger, Fin tube heat exchanger	20-21
13.	Indicator unit	Piston indicator, Balanced diaphragm type indicator, Electronic indicator, Optical indicator	22

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Engineering Thermodynamics	James Ambrose Moyer	Maxwell Press,2022 ISBN-10: 9355282001 ISBN-13: 978-9355282002
2.	Engineering Thermodynamics	R.K. Singal Mridul Singal Rishi Singal	Dreamtech Press, 2020 ISBN-10: 9389698669, ISBN-13: 978-9389698664
3.	Heat and Mass Transfer - Fundamentals and Applications	Yunus A. Cengel Afshin J. Ghajar	McGraw Hill, Ed.6th ISBN-10: 9390185289 ISBN-13: 978-9390185283
4.	Thermodynamics an engineering approach	Yunus A. Cengel Michael A. Boles Mehmet Kanoglu	McGraw Hill Education India, 2019 ISBN: 9789353165741, 9353165741
5.	Applications of Thermodynamics	V. Kadambi T. R. Seetharam K. B. Subramanya Kumar	Wiley, 2019 ISBN-10 : 8126571241 ISBN-13 : 978-8126571246
6.	Basic and applied thermodynamics	P.K. Nag	McGraw Hill Education india, Ed.2nd 2017, ISBN: 9780070151314,9780070151314
7.	Thermal Engineering	R.S. Khurmi	S Chand, 2020 ISBN-10 : 9788121925730 ISBN-13 : 978-8121925730
8.	A course in Thermal Engineering	Domkundwar, Kothandaraman	Dhanpat Rai and company, 2017 ASIN : B0B5KRKDHS

(b) Online Educational Resources:

1. https://www.youtube.com/watch?v=gG9mzVV9FYA&list=PL9RcWoqXmzaK6AHCCyL_J6gqc02RN-w-D
2. https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8
3. https://www.youtube.com/watch?v=ZTpnJZu1IQw&list=PLiSPNzs4fD9snxh0jHSuk3HuqoMhW24VO
4. https://archive.nptel.ac.in/courses/112/108/112108148/
5. https://archive.nptel.ac.in/courses/112/108/112108149/

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. Conference paper
2. Journal paper
3. Lab Manuals

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A) Course Code : **2425305 (P2425305/S2425305)**

B) Course Title : Computer Aided Drafting and Modelling (ME, ME (Auto))

C) Pre- requisite Course(s) : Engineering Drawing

D) Rationale :

With the emergence of computer-aided drafting and design (CAD) tools the traditional engineering drawing practices has undergone significant change as the emphasis has shifted from drawing board based engineering practices to Computer aided based drafting and modeling which has the advantages of speed, modification, storage and convenience of drawing complex 2D and 3D entities. This course makes them able to use computer aided drafting and design software for developing 2D & 3D digital entities, Digital engineering drawings and Assemblies related to different fields. The goal of this course is to make the student proficient in the most up-to-date drafting, solid modeling and assembly practices through providing them with hands-on experience.

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

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

CO-1 Use Computer Aided Drafting software to draw simple and complex 2D geometric entities.

CO-2 Use Computer Aided Drafting software to draw orthographic and isometric projections.

CO-3 Use Computer Aided Design Software to model 3D components and assemblies.

CO-4 Use Computer Aided Design Software to create engineering drawings of machine components and assemblies.

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

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

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

G) Teaching & Learning Scheme:

Board of Study	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				
Mechanical Engineering	**2425305**	Computer Aided Drafting and Modelling	-	-	04	02	06	03

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:

Board of Study	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)	
Mechanical Engineering	**2425305**	Computer Aided Drafting and Modelling	-	-	20	30	20	30	100

Legend:

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

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

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

Note:

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

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

J) Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Use the given computer aided drafting software for creating the institute Drawing Template.	**Unit-1.0 Basic Computer Aided Drafting** 1.1 Various Software for Computer Aided Drafting and Computer Aided Design.	**CO1**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1b. Use drawing commands to create the given simple 2D geometry. *TSO 1c.* Apply drawing aids, coordinate system, selection methods, and templates to create the given drawing quickly and precisely. *TSO 1d.* Use the given computer aided drafting software for creating the given simple 2D entity.	1.2 Basics of AutoCAD or any other drafting software–interface, screen layout, starting commands from menus, command line. 1.3 Coordinate system, Angular measurements, Point specification. 1.4 Drawing aids - Grid, Snap, Ortho, Osnap, Units, Limits, Layers, Linetype. 1.5 Opening and Saving drawing files. 1.6 Creating User Defined Templates. 1.7 Methods of Selecting and deleting Objects. 1.8 Undo and Redo. 1.9 Creating basic drawings objects - lines, arc, circles, ellipses, polyline and polygons.	
TSO 2a. Use modifying commands to create the given complex 2D entity. *TSO 2b.* Use hatching, text and dimensioning, tolerance and formatting commands to make the given complex 2D drawings. *TSO 2c.* Use layers and blocks to handle complex 2D drawings. *TSO 2d.* Use the given computer aided drafting software for creating the given complex 2D entity. *TSO 2e.* Print the given drawing (using institute template) on A4/A3 sheet.	**Unit-2.0 Advanced Computer Aided Drafting** 2.1 Modify 2D entities: Erase, Trim, Extend, Copy, Move, Mirror, Offset, Fillet, Chamfer, Array, Rotate, Scale, Lengthen, Stretch, Break, Divide, Exploded and Block, Hatch etc. 2.2 Text and Dimensioning, Dimensional tolerances and Geometrical tolerances. 2.3 Formatting commands- Line weight, Color, Line type, Dimension style. 2.4 Controlling Drawing display. 2.5 Layers: concept and application. 2.6 Printing and plotting of drawings- Paper space, Model space, creating table, Plot commands.	**CO1**
TSO 3a. Use the given computer aided drafting software for creating orthographic views of the given object. *TSO 3b.* Use the given computer aided drafting software for creating isometric views of the given object.	**Unit-3.0 Application of Computer Aided Drafting** 3.1 Drawing orthographic views using drafting software with principles mentioned in 'Engineering Drawing' Course. 3.2 Drawing isometric views using drafting software with principles mentioned in 'Engineering Drawing' Course.	**CO1, CO2**
TSO 4a. Explain solid modeling, surface modeling and assembly operation in the available CAD software. *TSO 4b.* Use the given computer aided Design software to create 2D entities with constraints and parametric relations.	**Unit-4.0 Computer Aided Design Software-Working in 2D Environment** 4.1 Introduction, features, and applications of different software packages used for solid modeling. System requirement & compatibility with other software. 4.2 Working in Sketcher mode - Line, Profile, Circle, Arc, curves, Rectangle, and their sub options. 4.3 Constraints-Dimensioning constraint, Geometrical constraint.	**CO3**
TSO 5a. Create the given 3D model (part) using the given commands and parametric relations. *TSO 5b.* Describe the procedure to use 3D modify commands to edit the given 3D Model. *TSO 5c.* Create assembly of the given 3D solid (Part) models using the CAD software.	**Unit-5.0 Computer Aided Design Software-Solid Modeling and Assembly** 5.1 Introduction to Computer Aided Design Software and different modules. 5.2 Working in 3D environment 5.3 Creating 3D Solid Models of simple and	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 5d. Modify the given assembly using the CAD software. *TSO 5e.* Describe the procedure to use explode command for the given assembly.	complex machine parts using Extrude, Revolve, Sweep, variable section sweep, Draft, loft, Blend, creating reference planes, points and lines, and similar 3D commands. 5.4 Part editing tool: Trim, Extend, Erase, Mirror, Chamfer, Round, Copy, Move, Draft, Boolean operations, Patterns, etc. 5.5 Parametric and non parametric modeling-concept, differences and illustration. 5.6 Preparation of assemblies using assembly commands. Introduction to Top down and Bottom up approach of assembly 5.7 Exploded view: Explode the assembly.	
TSO 5f. Describe the procedure to generate 2D drawings of the given part models and assembly using the CAD software. *TSO 6a.* Plot production drawing as per the given dimensions, parts and assemblies.	**Unit-6.0 Drafting and Plotting using Computer Aided Design Software** 6.1 Generate orthographic projections from already available Part Models and Assemblies. All types of views – front view, top view, side view, sectional views, isometric views, auxiliary views. 6.2 Dimensioning Commands – Apply dimensions, dimensional and geometrical tolerances. 6.3 Preparation of Assembly drawing using assembly features. 6.4 Working in Drafting Mode. 6.5 Bill of material – Prepare part list table and name plate. 6.6 Page set up, Plot command.	**CO4**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2425305

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use the given Computer aided Drafting software. *LSO 1.2.* Draw standard 2D entities using Draw commands.	1.	Use the Computer Aided Drafting software to draw following simple 2-D entities using Draw commands • Draw circle and arcs with different geometric conditions and constraints (two problems). • Draw polygons (Triangle, square, pentagon, hexagon, heptagon) (Three problems).	CO1
LSO 2.1. Customize the given Computer aided drafting software as per requirements. *LSO 2.2.* Use readymade templates to draw 2D entities.	2.	• Use customization tool bar of CADr software to customize main window and to do interfacing. • Use existing standard 2D drawing templates.	CO1
LSO 3.1. Use the given Computer aided Drafting software to create template as per requirement.	3.	Prepare a template for your institute of A-4 size with title block and institute logo using the Computer Aided Drafting software.	CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 3.2. Insert already prepared 2D entities in the template using modify commands			
LSO 4.1. Estimate areas and perimeters of regular and complex 2D entities using software.	4.	Use the Computer Aided Drafting software to estimate Area, Perimeter, and Centroid for the given 2D entities like Circle, Pentagon, Trapezium, hexagon and 2D entity with arcs and spline curves using 'Enquiry' and 'List' commands.	CO1
LSO 5.1. Draw conic sections using software. *LSO 5.2.* Draw popular engineering curves for engineering applications.	5.	Use the Computer Aided Drafting software to draw: • Ellipse and parabola • Epicycloid and Hypocycloid curves using pitch circle as directing circle of a cycloidal gear and an appropriate size smaller circle as generating circle • Involute of a circle	CO1
LSO 6.1. Use various Draw, Edit and Modify commands to create complex 2D entities.	6.	Use the Computer Aided Drafting software to draw four complex 2D entities assigned by the teacher using Draw, Edit and Modify commands	CO1
LSO 7.1. Use Computer aided Drafting software to create and modify 2D entities. *LSO 7.2.* Use computer aided drafting software to create and modify the given orthographic views.	7.	Use the Computer Aided Drafting software to draw Orthographic projections of following using first angle method: • A pentagonal pyramid is placed in first quadrant with its axis parallel to H.P. and V.P • A frustum of a hexagonal is placed in first quadrant with its axis perpendicular to H.P. and parallel to V.P • Different objects having cylindrical surfaces, ribs.	CO2
LSO 8.1. Use computer aided drafting software to create and modify the given orthographic views of mechanical components.	8.	Use the software to draw Orthographic projections of following using first angle method: • Front and side view of V-Groove Pulley • Front view of 2-Wheeler Piston • Front view of typical Open Ended Spanner • Front view of Connecting Rod (similar objects can be taken up)	CO2
LSO 9.1. Use dimensional and Geometric tolerance and text to the given 2D drawing.	9.	Apply geometrical tolerance, dimensional tolerance and text to the drawing drawn under Sr. No. 6 to 8.	CO1
LSO 10.1. Use of layer to handle complex 2D entities.	10.	Use the software to draw sectional view of piston of a two-wheeler. Main drawing of Piston in one layer, hatching in another layer and dimensioning and text in third layer	CO1
LSO 11.1. Use computer aided drafting software to create and modify the given isometric entities.	11.	Use the software to draw isometric views of three 3D objects containing lines, arcs, circles, holes, ribs and slots	CO2
LSO 12.1. Visualize the 3D shape of the given object. *LSO 12.2.* Convert the given 2D figures/views into isometric views.	12.	Convert the orthographic views of an object to isometric view (Two problems)	CO2
LSO 13.1. Print drawing on A4 and A3 papers with dimensions and text.	13.	Print any three drawings from above list along with the template of institute prepared.	CO1
LSO 14.1. Use the given Computer Aided Design (CAD) Software	14.	• Customize main window and interface of the 3D modeling software using customization tool bar.	CO3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 14.2. Customize the given CAD Software *LSO 14.3.* Create simple 3D parts models using the given CAD Software		• Create given simple part models using commands like Extrude, Revolve, Shell etc.;	
LSO 15.1. Create Complex 3D parts models using the given CAD Software	15.	Create the given complex 3D part model(s) using advanced commands like Sweep, Variable Section Sweep, Blend, Draft, Mirror, Chamfer, Fillet, Rib, Pattern etc.	CO3
LSO 16.1. Create Simple mechanical 3D parts models using the given CAD Software	16.	Develop following mechanical components: • Stepped shaft • Muff coupling • Hexagonal nut • Hexagonal bolt • Cast Iron Pulley	CO3
LSO 17.1. Create mechanical 3D parts models and assemblies using the given CAD Software	17.	Develop following mechanical components and assemblies: • Cotter joint • Flange coupling • Screw jack • Tool Post • Bench vice • Plummer Block • Drill Jig • (OR any six similar components)	CO3
LSO 18.1. Print Production drawings related o mechanical components and assemblies using the given CAD software.	18.	• Print orthographic views (regular and sectioned) of the solid models developed under Sr. No. 16 • Print drawing of the solid models developed Sr. No. 16 • Print drawing of the assembly developed Sr. No. 17 with Bill of Materials.	CO4

L) Suggested Term Work and Self Learning: S2425305 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments:

1. Differentiate Parametric and Non parametric modeling approaches with example.
2. List sketch based commands available in any parametric CAD software.
3. List feature based commands available in any parametric CAD software.
4. Explain the procedure of creating and inserting 'Blocks' in AutoCAD software.
5. Explain the procedure of modeling a Ball bearing and Helical Gear using any parametric CAD software.
6. Explain the procedure of modeling open coil helical spring using any parametric CAD software.
7. Draw Front and Top views of Hexagonal bolt in AutoCAD and convert it into blocks. Insert copies of these blocks in other AutoCAD files.
8. Each student should explain at least one problem for construction and method of drawing/modeling in computer to all batch colleagues. Teacher will assign the problem to be explained to each student batch.

9. Each student will assess at least one 2D digital drawing/part model of other students (May be a group of 5-6 students identified by teacher can be taken) and will note down the mistakes committed by them. Student will also guide the students for correcting the mistakes, if any.

b. Micro Projects:

1. Prepare an A4 digital drawing template of your institute with title block and institute logo.
2. Download 5 videos on shortcuts used in AutoCAD, watch them and write a report to detail out the steps involved, Commands used.
3. Each student will identify a small assembly from the institute workshop/laboratory (e.g. Bench vice, Machine vice, Tool post, Couplings, Joints, Ball/Roller Bearings, Gears, Mouse, Motor casing etc.) Or any items like White Board Marker pen, TV Remote, 3 pin electrical Top of charger, Tooth Brush etc. Specify the material and try to find out mass of the complete assembly/object.
4. Develop 3D model and complete assembly of 'computer mouse' you are using, specify the material and try to find out mass of the complete assembly.
5. Down load already prepared solid models and modify them.

c. Other Activities:

1. Seminar Topics:
   - Commercially available other Computer Aided Drafting Software
   - Compatibility of AutoCAD drawings compared to Conventional Drawing
   - Commercially available other Computer Aided Design Software
   - Effective use of Layers in AutoCAD
   - Surface Modelling
   - Parametric Modelling
2. Visits: Collect production/construction/circuit drawings from nearby industries/shop/builders and develop 2D digital drawing and 3D model of any of the component.
3. Self-learning topics:
   - Arrays in AutoCAD
   - Blocks in AutoCAD
   - Modelling of threaded components
   - Modelling of Spur Gear
   - Modelling of Ball Bearing.

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

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

O) Suggested AssessmentTable for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Use the Computer Aided Drafting software to draw following simple 2-D entities using Draw commands • Draw circle and arcs with different geometric conditions and constraints (two problems). • Draw polygons (Triangle, square, pentagon, hexagon, heptagon) (Three problems).	CO1	30	60	10
2.	• Use customization tool bar of CADr software to customize main window and to do interfacing. • Use existing standard 2D drawing templates.	CO1	30	60	10
3.	Prepare a template for your institute of A-4 size with title block and institute logo using the Computer Aided Drafting software.	CO1	30	60	10
4.	Use the Computer Aided Drafting software to estimate Area, Perimeter, and Centroid for the given 2D entities like Circle, Pentagon, Trapezium, hexagon and 2D entity with arcs and spline curves using 'Enquiry' and 'List' commands.	CO1	30	60	10
5.	Use the Computer Aided Drafting software to draw: • Ellipse and parabola • Epicycloid and Hypocycloid curves using pitch circle as directing circle of a cycloidal gear and an appropriate size smaller circle as generating circle • Involute of a circle	CO1	30	60	10
6.	Use the Computer Aided Drafting software to draw four complex 2D entities assigned by the teacher using Draw, Edit and Modify commands	CO1	30	60	10
7.	Use the Computer Aided Drafting software to draw Orthographic projections of following using first angle method: • A pentagonal pyramid is placed in first quadrant with its axis parallel to H.P. and V.P • A frustum of a hexagonal is placed in first quadrant with its axis perpendicular to H.P. and parallel to V.P • Different objects having cylindrical surfaces, ribs.	CO2	30	60	10
8.	Use the software to draw Orthographic projections of following using first angle method: • Front and side view of V-Groove Pulley • Front view of 2-Wheeler Piston • Front view of typical Open Ended Spanner • Front view of Connecting Rod (similar objects can be taken up)	CO2	30	60	10
9.	Apply geometrical tolerance, dimensional tolerance and text to the drawing drawn under Sr. No. 6 to 8.	CO1	40	50	10
10.	Use the software to draw sectional view of piston of a two-wheeler. Main drawing of Piston in one layer, hatching in another layer and dimensioning and text in third layer	CO1	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
11.	Use the software to draw isometric views of three 3D objects containing lines, arcs, circles, holes, ribs and slots	CO2	40	50	10
12.	Convert the orthographic views of an object to isometric view (Two problems)	CO2	40	50	10
13.	Print any three drawings from above list along with the template of institute prepared.	CO1	40	50	10
14.	• Customize main window and interface of the 3D modeling software using customization tool bar. • Create given simple part models using commands like Extrude, Revolve, Shell etc.;	CO3	40	50	10
15.	Create the given complex 3D part model(s) using advanced commands like Sweep, Variable Section Sweep, Blend, Draft, Mirror, Chamfer, Fillet, Rib, Pattern etc.	CO3	40	50	10
16.	Develop following mechanical components: • Stepped shaft • Muff coupling • Hexagonal nut • Hexagonal bolt • Cast Iron Pulley	CO3	40	50	10
17.	Develop following mechanical components and assemblies: • Cotter joint • Flange coupling • Screw jack • Tool Post • Bench vice • Plummer Block • Drill Jig • (OR any six similar components)	CO3	40	50	10
18.	• Print orthographic views (regular and sectioned) of the solid models developed under Sr. No. 16 • Print production drawing of the solid models developed Sr. No. 16 Print production drawing of the assembly developed Sr. No. 17 with Bill of Materials.	CO4	40	50	10

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

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

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

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

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Computer aided drafting software like AutoCAD	Latest educational licensed network version	1 to 13
2.	Computer Aided Design Software like CATIA, CREO, NX, Solid works etc.	Latest educational licensed network version	14 to 18
3.	CAD workstations	latest configuration Processor Intel Core i7 with Open GL Graphics Card, RAM 32 GB, DDR3/DDR4, HDD 500 GB, Graphics Card NVIDIA OpenGL 4 GB, OS Windows 10	All
4.	Interactive board (165 x 130 cm)	Supports dual touch, dual write and intuitive gestures, such as toss, rotate and zoom, available with multitouch operating systems, such as Windows®	All
5.	Sample production/construction drawings	From nearby industries, construction companies and developed by senior teachers of the state	All
6.	Printer/plotter	A4/A3 size	13, 18
7.	Models for projection and demonstration	Wooden models	All

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Engineering Graphics with AutoCAD	A.K. Sarkar, A.P. Rastogi, D.M. Kulkarni	PHI Learning Private Limited-New Delhi (2010); ISBN: 978-8120337831.
2.	Computer Aided Drafting & Modelling Lab	K.Venugopal	Scitech Publications (India) Pvt Ltd, ISBN-10 : 8183714366
3.	Engineering Graphics	S. K. Pradhan K.K. Jain	Khanna Book Publishing Company Pvt. Ltd., New Delhi ASIN : B0BM5BMMXT ISBN-10 : 9355381891 ISBN-13 : 978-9355381897
4.	Catia V5r16 for Designers	Sham Tickoo	CADCIM Technologies, USA (2006) ISBN-10 : 1932709185 ISBN-13 : 978-1932709186
5.	Creo Parametric 9.0 for Designers	Sham Tickoo	CADCIM Technologies, USA 9th ed, 978-1-64057-163-1
8.	NX 9.0 for Designers	Sham Tickoo	BPB Publications, (2017) ISBN-10 : 9386551225 ISBN-13 : 978-9386551221

(b) Online Educational Resources:

1. Scales: https://youtu.be/YSEZu3Ch26k
2. Dimensioning: https://youtu.be/_OSY04TnlEM
3. Simple Orthographic Projections: https://youtu.be/DW7dpKdxVrA
4. Orthographic Projections of objects with slant and curved surfaces: https://youtu.be/dCWjBvZBpjM
5. Illustrative Example: https://youtu.be/MR5de9EC940

6. Illustrative Example: https://youtu.be/mahh-WONNHA
7. Isometric Projection of 3D objects: https://youtu.be/0K-5URiyi50
8. Isometric Projection-Object with slant surfaces: https://youtu.be/qSPJOiXKv98
9. Isometric Projection-Object with curved surfaces: https://youtu.be/qSPJOiXKv98
10. Missing lines and missing views: https://nptel.ac.in/courses/105/104/105104148/
11. Launching AutoCAD and Opening drawing: https://youtu.be/aoo-t0-gEfw
12. AutoCAD Main Screen: https://youtu.be/D0YyEiCjwpk
13. Draw and Modify Toolbars: https://youtu.be/T_RN_RBFk7o
14. Illustrative Example-1: https://youtu.be/_Bheo9MzeVk
15. Block creation: https://youtu.be/ZguZZVjxaek
16. Rectangular and Polar array : https://youtu.be/YgYZgbrUJ_M
17. Illustrative Example-2: Array: https://youtu.be/yJf_IsWX4gM
18. Dimensioning: https://youtu.be/sEiRsi14u0U
19. Use of layers: https://youtu.be/fdQqNdDtOI8
20. Illustrative Example 3: Flywheel: https://youtu.be/AU-Vsd2T0DA
21. https://www.inc.com/encyclopedia/computer-aided-design-cad-and-computer-aided-cam.html
22. https://all3dp.com/2/surface-modeling-cad-simply-explained/
23. http://www.dm.unibo.it/~casciola/html/research_ssm.html
24. https://www.youtube.com/watch?v=WY0YuCkJWdw
25. https://www.youtube.com/watch?v=OIYrkF_FId8
26. https://www.youtube.com/watch?v=zoMW_usjaJo
27. https://www.youtube.com/watch?v=fx6kt9djIpc
28. https://www.youtube.com/watcAh?v=8wdOIHxICxw
29. https://www.youtube.com/watch?v=srnm--IKtl4
30. https://www.youtube.com/watch?v=rtjDfZXscrI

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. Bureau of Indian Standards, Engineering Drawing Practice for Schools and Colleges IS: SP-46, BIS, Government of India, Third Reprint, October 1998; ISBN: 81-7061-091-2.
2. AutoCAD e manual
3. Already prepared Production Drawings

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A) Course Code : 2425306 (P2425306/S2425306)

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

C) Pre- requisite Course(s) :

D) Rationale :

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

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

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

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

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

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Board of Study	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				
	2425306	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:

Board of Study	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)	
	2425306	Summer Internship -I	-	-	10	15	10	15	50

Legend:

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

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

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

Note:

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

I) Suggested Instructional/Implementation Strategies: Mentors/ Coordinators/ Teachers need to plan and implement the summer internship in their respective programme as per the outcome expected from the programme. However in general, summer internship would help in exploring and exposing the student to the below mentioned dimensions of the world of work. These dimensions can further be explored in depth as per the need and advancement in respective programmes in later stages.

Mentors/Coordinators/ Teachers need to map the academic contents of the programme of study with the activities of this industrial exposure and are advised to follow the whole to part approach to make the students aware about the potential industry's expected outcomes & setup ('Whole') from the specific diploma programme and then teaching the related concepts ('Part') of the same in subsequent semesters.

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

J) Assessment of Summer Internship -I

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

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

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A) Course Code : 2400207(T2400207)

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 List salient features and characteristics of the constitution of India.

CO-2 Follow fundamental rights and duties as responsible citizen and engineer of the country.

CO-3 Analyze major constitutional amendments in the constitution.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Board of Study	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				
	2400207	Indian Constitution	01	-	-	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:

Board of Study	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)	
	2400207	Indian Constitution	25	-	25	-	-	-	50

Legend:

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

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

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

Note:

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

I) Course Curriculum Detailing:

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: T2400207

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.	**Unit-1.0 Constitution and Preamble** 1.1 Meaning of the constitution of India.	**CO1**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	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.	
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.	**Unit-2.0 Fundamental Rights and Directive Principles** 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.	**CO2**
TSO 3a. Enlist the constitutional amendments. *TSO 3b.* Analyze the purposes of various amendments.	**Unit-3.0 Governance and Amendments** 3.1 Amendment of the Constitutional Powers and Procedure 3.2 Major Constitutional Amendment procedure - 42nd, 44th, 74th, 76th, 86th and 91st	**CO3**

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

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

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

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

b. Micro Projects:

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

c. Other Activities:

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

6. **Cases**: Suggestive cases for usage in teaching:

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

7. Self-learning topics:

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

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

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

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

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

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

Q) List of Major Laboratory Equipment, Tools and Software: (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, 6thedition, 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
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://legalaffairs.gov.in/sites/default/files/chapter%203.pdf
10. 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 recourses before use by the students.

(c) Others:

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A) Course Code : 2400108 (T2400108)

B) Course Title : Essence of Indian Knowledge System and Tradition (Common for all Programmes)

C) Pre- requisite Course(s) :

D) Rationale :

This course will survey the basic structure and operative dimensions of Indian knowledge system. With the new education policy-NEP 2020 focusing on Indian Knowledge Systems (IKS) and Traditions of India. This course introduces the learners to the rich and varied knowledge traditions of India from antiquity to the present. This also helps the learner to know and understand their own systems and traditions which are imperative for any real development and progress. Also, it helps the learner to think independently and originally adopting Indian frameworks and models for solving the problems related to world of work where the student is supposed to perform.

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 Identify the rich heritage and legacy residing in our Indian Knowledge systems.

CO-2 Correlate the technological & philosophical concepts of IKS with engineering domain specific problems and local problems for finding out possible solutions.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Board of Study	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				
	2400108	Essence of Indian Knowledge System and Tradition	01	-	-	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:

Board of Study	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)	
	2400108	Essence of Indian Knowledge System and Tradition	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:

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: T2400108

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the architecture of the Ancient Indian Knowledge Systems. *TSO 1b.* List the salient features of IKS. *TSO 1c.* Comprehend the given IKS model. *TSO 1d.* Identify the role and relevance of the given IKS model in contemporary society.	**Unit-1.0 Introduction to Indian Knowledge Systems** 1.1 Overview of IKS 1.2 Organization of IKS – चतुर्दश-विद्यास्थानं 1.3 Conception and Constitution of Knowledge in Indian Tradition 1.4 The Oral Tradition 1.5 Models and Strategies of IKS	**CO1**
TSO 2a. Enlist the importance of Veda, Vedanga, Visaya, Siksaka. *TSO 2b.* Describe the given IKS domain. *TSO 2c.* Identify elements of mentioned IKS domains that are relevant to Technical Education System. *TSO 2d.* Correlate the elements of mentioned IKS domains with given engineering domain.	**Unit-2.0 Overview of IKS Domains and Relevance in Current Technical Education System.** 2.1 The Vedas as the basis of IKS 2.2 Overview of all the six Vedāṅgas 2.3 Relevance of following IKS domains in present Technical Education System: • Arthashastra (Indian economics and political systems) • Ganita and Jyamiti (Indian Mathematics, Astronomy and Geometry • Rasayana (Indian Chemical Sciences) • Ayurveda (Indian Biological Sciences / Diet & Nutrition) • Jyotish Vidya (Observational astronomy and calendar systems) • Prakriti Vidya (Indian system of Terrestrial/ Material Sciences/ Ecology and Atmospheric Sciences) • Vastu Vidya (Indian system of Aesthetics-Iconography and built-environment /Architecture) • Nyaya Shastra (Indian systems of Social Ethics, Logic and Law) • Shilpa and Natya Shastra (Indian Classical Arts: Performing and Fine Arts) • Sankhya and Yoga Darshna (Indian psychology, Yoga and consciousness studies) • Vrikshayurveda (Plant Science / Sustainable agriculture/food preservation methods)	**CO1, CO2**

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. Write a report on any IKS domain highlighting the correlation with one domain specific engineering course.

c. Other Activities:

1. Seminar Topics: discuss any one IKS domain in details a highlighting the eminent works in the area.
2. Visits:
   - Visit any nearby ancient temple and corelate the geomatical, Shilpa and Vaastu on IKS dimensions specified in each domain.
3. Self-learning topics:
   - Sustainable practices adopted in ancient India that can be applied for current engineering situations.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	-	-	-	-	-	-	-
CO-2	100%	-	100%	100%	100%	-	-
Total Marks	25	-	5	10	10	-	-
			25				

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

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

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

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

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Introduction to Indian Knowledge System: Concepts and Applications	Archak, K.B. (2012).	Kaveri Books, New Delhi
2.	Introduction to Indian Knowledge System: Concepts and Applications	Mahadevan, B. Bhat, Vinayak Rajat Nagendra Pavana R.N.	PHI, ISBN: 9789391818203
3.	Glimpse into Kautilya's Arthashastra	Ramachandrudu P. (2010)	Sanskrit Academy, Hyderabad
4.	"Introduction" in Studies in Epics and Purāṇas, (Eds.)	KM Munshi and N Chandrashekara Aiyer	Bhartiya Vidya Bhavan

(b) Online Educational Resources:

1. http://bhavana.org.in
2. www.academia.edu/23254393/Science_in_Ancient_India_-_an_educational_module
3. www.academia.edu/23305766/Technology_in_Ancient_India_-_Michel_Danino
4. www.hamsi.org.nz/http://insaindia.res.in/journals/ijhs.php
5. www.niscair.res.in/sciencecommunication/ResearchJournals/rejour/ijtk/ijtk0.asp
6. www-history.mcs.st-andrews.ac.uk/Indexes/Indians.html

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

(c) Others:

1. Swami Harshananda. "A bird's eye view of vedas". R K Math. Bangalore.,http:// rkmathbangalore. org/Books/ABirdsEyeViewOfTheVedas.pdf.
2. Sanskrit Prosody, https://en.wikipedia.org/wiki/Sanskrit_prosody.
3. Vartak, P.V. (1995). "Veda and Jyotish," Part II, Chapter 2, in Issues in Veda and Astrology, H Pandya (Ed.), pp 65 – 73.
4. Sundaram, A.V. (1995). "Astrology: Its usefulness and Limitations in ModernTimes", Part II, Chapter 9, in Issues in Veda and Astrology, H Pandya (Ed.), pp 129 – 135.
5. Archak, K.B. (2012), "The Vedāṅga Literature", Chapter VIII in Essentials of Vedic Literature, Kaveri Books, New Delhi, pp 330 – 391.
6. Vasant Lad (1996), "Ayurveda: A Brief Introduction and Guide", (whole article).

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A) Course Code : **2400110 (T2400110)**

B) Course Title : Community/ Society Development (Non-Exam Course)

(AIML, AE, CSE, ELX (R), CHE, EE, ME, ME (Auto), MIE, FTS, CACDDM)

C) Pre- requisite Course(s) :

D) Rationale :

Community development is a process in which community members collectively generate solutions to common problems/concerns for improvement in the quality of life of the people. The course in community and society development is essential so that students can be prepared for taking up activities for the welfare and social well-being of the community and society around them. This course has been designed to develop requisite competencies and skills in students so that they can address social problems, develop sustainable solutions that are tailored to local needs and resources, engage with local communities and civil society organizations to promote people's participation in decision-making and accountability, and apply them to community development.

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 Identify the issues and problems faced by local communities/societies that can be addressed through community development schemes for sustainable development.

CO-2 Prepare an action plan for an identified issue under community development scheme for a selected area.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Board Of Study	Course Code	Course Title	Scheme of Study (Hours/Week)				
			Classroom Instruction (CI)		Notional Hours (TW/ Activities+ SL)	Total Hours (CI+TW/ Activities)	To Cr
			L	T			
	2400110	Community/ Society Development	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) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

I) Theory Session Outcomes (TSOs) and Units: T2400110

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the concept of to Community/Society in Indian Context *TSO 1b.* Explain the concept of Rural and Urban Society *TSO 1c.* Differentiate between Rural and Urban Societies. *TSO 1d.* Differentiate between Underdevelopment and development. *TSO 1e.* Describe the different components of community development	**Unit-1.0 Community and Society Development Framework** 1.1 Concept of Community/Society Development 1.2 Difference between Rural and Urban Societies 1.3 Characteristics of Underdevelopment and development 1.4 Components of Community Development	**CO1**
TSO 2a. Prepare a brief report on Community Development Programmes in India considering the given criteria *TSO 2b.* Prepare a brief report on institutions engaged in community development programmes considering the given criteria *TSO 2c.* Explain the framework of sustainable community development	**Unit-2 Community Development Initiatives** 2.1 Community Development Programmes in India-Historical perspective 2.2 Institutions Engaged in Community Development Programmes 2.3 Contemporary Community Development Initiatives. 2.4 Sustainable Community Development	**CO1, CO2**
TSO 3a. Explain Role of Technical Intuitions in Community/Society development. *TSO 3b.* Summarise the activities undertaken by technical institutions under community development through polytechnic scheme *TSO 3c.* Prepare a plan for undertaking project to support Unnat Bharat Abhiyan	**Unit-3.0 Community Development Schemes** 3.1 Role of polytechnics in Community development. 3.2 Scheme of Community Development through Polytechnics 3.3 Unnat Bharat Abhiyan	**CO3, CO4**

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: Specific assignments will be given to students for preparing report on community development programmes and institutions engaged in community development programmes.

b. Micro Projects:

1. Suggest solution for flowing water near a water source.
2. Identify locally available construction materials in a village.
3. Suggest a plan for disposal of solid waste in a village.
4. Prepare a plan for use of solar light equipments at streets and public places.

c. Other Activities:

1. Seminar Topics:
    - Issues of development for a village near to the institution.
    - Activities to be undertaken by the polytechnic in a village.
    - Characteristics of Development and underdevelopment.

2. Visits: Visit to nearby village may be arranged and students may be asked to prepare list of development activities in different Discipline.

3. Self-learning topics:
    - Community Development programmes in India after independence.
    - Schemes of GOI for Community /society Development.

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 and Reports:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Module on Rural Development: Indian Context	IGNOU, New Delhi	Published by IGNOU, New Delhi
2.	Module on Rural Development Programmes	IGNOU, New Delhi	Published by IGNOU, New Delhi
3.	Module on Rural development planning and management	IGNOU, New Delhi	Published by IGNOU, New Delhi
4.	India's Developing Villages	G R Madan	Allied Publishers, 1990
5.	Five year plans, Plan Documents, Policy and Reports	Planning Commission of India publications	Planning Commission of India
6.	Scheme of Community Development through Polytechnics	Ministry of Human Resourse Development,	Ministry of Human Resourse Development, Govt of India, New

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
		Shastri Bhavan ,New Delhi	Delhi

(b) Online Educational Resources:

1. https://www.google.co.in/books/edition/Rural_Development/hABduOX-X-gC?hl=en&gbpv=1&dq=rural+development+latest+books&printsec=frontcover
2. https://www.india.gov.in/my-government/documents/plan-document
3. https://www.india.gov.in/website-planning-commission

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. Project Reports Available in the office of CEO, Zila Parishad of the District.
2. Schemes of various departments of Bihar Government for Community/Social Development

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