Curriculum of Diploma Programme

in

Medical Laboratory Technology

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

State Board of Technical Education (SBTE), Bihar

Semester – II
Teaching & Learning Scheme

Course Codes	Category of course	Course Titles	Teaching & Learning Scheme (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
2420103	**BEC**	**Fundamentals of Electrical and Electronic Engg.** (CSE, AIML, ME, ME (Auto), MIE, CRE)	03	-	04	02	09	06
2425103	**BEC**	**Fundamentals of Mechanical Engg.** (CE, CRE, CHE)	03	-	04	02	09	06
2425104	**BEC**	**Engg. Mechanics** (CE, EE, ME, ME (Auto), MIE, FTS, AE, CRE, CHE, ELX, ELX (R), TE)	03	-	04	02	09	06
2400105A	**ASC**	**Applied Mathematics -A** ME, ME (Auto), CE, MIE, AE, CHE, FTS, CRE)	02	01	-	02	05	04
2415105	**BEC**	**Engg. Drawing & Graphics** (MIE, AE, CRE, CE, CHE, FTS, TE, EE, ELX, ELX (R))	-	-	04	02	06	03
2425106	**BEC**	**Mechanical Workshop** (ME, ME (Auto), MIE, AE, CRE, CE, CHE)	-	-	04	02	06	03
2400006	**NRC**	**Environmental Education and Sustainable Development** (Common for All Programmes)	01	-	01	01	03	02
Total			**12**	**1**	**21**	**13**	**47**	**30**

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

Legend:

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

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

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

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

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

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

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

Semester - II
Assessment Scheme

Course Codes	Category of course	Course Titles	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment(LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2420103	**BEC**	**Fundamentals of Electrical and Electronic Engg.** (CSE, AIML, ME, ME (Auto), MIE, CRE)	30	70	20	30	20	30	200
2425103	**BEC**	**Fundamentals of Mechanical Engg.** (CE, CRE, CHE)	30	70	20	30	20	30	200
2425104	**BEC**	**Engg. Mechanics** (CE, EE, ME, ME (Auto), MIE, FTS, AE, CRE, CHE, ELX, ELX (R), TE)	30	70	20	30	20	30	200
2400105A	**ASC**	**Applied Mathematics -A** (ME, ME (Auto), CE, MIE, AE, CHE, FTS, CRE)	30	70	20	30	-	-	150
2415105	**BEC**	**Engg. Drawing & Graphics** (MIE, AE, CRE, CE, CHE, FTS, TE, EE, ELX, ELX (R))	-	-	20	30	20	30	100
2425106	**BEC**	**Mechanical Workshop** (ME, ME (Auto), MIE, AE, CRE, CE, CHE)	-	-	20	30	20	30	100
2400006	**NRC**	**Environmental Education and Sustainable Development** (Common for All Programmes)	15	-	10	-	10	15	50
Total			**135**	**280**	**130**	**180**	**110**	**165**	**1000**

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

Legend:

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

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

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

Note:

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

A) Course Code **: 2420103/T2420103/P2420103/S2420103)**

B) Course Title **:** Fundamentals of Electrical and Electronic Engg.
(CSE, AIML, ME, ME (Auto), MIE, AE, CRE, CHE, TE)

C) Pre- requisite Course(s) **:** Engineering Physics, Basic Algebra and Calculus

D) Rationale :

This course is a fundamental course included in the curriculum mainly to introduce the students of Computer Science and Engineering, Artificial Intelligence and Machine Learning diploma courses to the basic concepts and basic laws of electricity, principle of magnetism and electromagnetic induction, basic electrical and electronics components and also to the basics of digital electronics so that students will be able to apply the same for solving the day to day basic electrical engineering problems in their own discipline. Diploma holders are expected to apply the fundamentals of this course while working with equipment being operated with electrical sources and while using various types of electrical equipment and instruments in their field.

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

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

CO-1. Apply basic concepts of electricity to determine various electric parameters in a given electrical system.
CO-2. Apply the fundamental laws and concepts of DC and AC circuits to a given electrical system.
CO-3. Apply the principles of magnetism and electromagnetism to a given equipment.
CO-4. Test the functionality of a given basic electronic component.
CO-5. Use Boolean expressions and number systems to realize the basic logic circuits.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)	
	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	2	2	-	2		
CO-2.	3	3	3	2	1	1	2		
CO-3.	3	3	3	2	2	-	2		
CO-4.	3	2	2	2	2	1	2		
CO-5.	3	2	2	2	2	1	2		

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2420103	Fundamentals of Electrical and Electronic Engineering	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 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, open educational resources (OERs)

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2420103	Fundamentals of Electrical and Electronic 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)

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Note:

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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: T2420103

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1a Apply the concept of charge, voltage and current in the given electrical circuit TSO.1b Differentiate between AC and DC currents. TSO.1c Differentiate between practical and Ideal current/voltage source TSO.1d Calculate work, power, and energy in the given circuit TSO.1e Calculate the equivalent resistance/Capacitance/ inductance in the given series and parallel electric circuit. TSO.1f Explain the heating/magnetic/chemical effect of the electric current with a relevant application. TSO.1g Calculate the energy stored in a given resistor/capacitor/inductor. TSO.1h Explain the effect of various media on capacitance TSO.1i Explain behavior of current in a resistor/capacitor/inductor.	**Unit-1.0 Basic Electrical Parameters and Concepts** 1.1 Electric charge, flow of charges, Electric Current D.C and A.C, Concept of ideal and practical current sources 1.2 Analogy of charge, potential /Voltage difference D.C and A.C, Induced emf/voltage, Terminal voltage, Concept of Ideal & Practical voltage sources 1.3 Resistor - Properties, Classification, Practical application of resistors, Effect of temperature on resistance, Series and parallel combination of resistors, Phase difference 1.4 Heating, magnetic and chemical effect of current, Electrical work, Power and energy, Open and short circuit condition of electric circuit 1.5 Capacitors – Properties, Capacitance formation, Expression for capacitance, Capacitive reactance, Energy stored in capacitor, Series & parallel combination of capacitors, Types of capacitors including super capacitors and their applications 1.6 Inductors – Properties, Self and mutual inductance, inductive reactance, Voltage and current equations of inductor, Energy stored in inductor, Inductance in A.C. and D.C. circuits, Types of Inductors including MEMS inductor and their applications	**CO-1**
TSO.2a Differentiate between- ● AC and DC current in all aspects (Generation, Waveforms and applications) ● Active and passive elements ● Linear & Non-linear circuit ● Unilateral and Bilateral circuit ● Loop and mesh in a given circuit TSO.2b Apply Ohm's law and Kirchhoff's laws to determine current and voltage in a given circuit. TSO.2c Explain various AC fundamental parameters. TSO.2d Use operator 'j' to calculate various quantities in A.C circuit	**Unit-2.0 Fundamentals of D.C. and A.C. Circuits** **DC Circuits** 2.1 AC and DC current, voltage and Power 2.2 Ohm's law, Kirchhoff's Current Law, Kirchhoff's Voltage law 2.3 Active & Passive elements, Linear & Non-linear circuit, unilateral and Bilateral circuit element, 2.4 Node, Branch, Loop, Mesh **A.C Circuits** 2.5 Frequency, Time period, Amplitude, Angular Velocity, RMS Value, Average Value, Form factor, Peak factor, Power factor 2.6 Phasor representation and transformation from Polar to rectangular form and vice versa of alternating quantities	**CO1, CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.3a Explain various terms related to magnetic circuit. TSO.3b Calculate various parameters of a given magnetic circuit. TSO.3c Plot B-H curve and Hysteresis loop of a given magnetic materials TSO.3d Explain the phenomenon of induced e.m.f and current TSO.3e Apply principles of Faraday's law to calculate induced e.m.f in the given circuit TSO.3f Apply various Laws in a given magnetic circuits	**Unit-3.0 Magnetic Circuits and Electromagnetic Induction** 3.1 Magnetic flux, Magnetomotive force, Magnetic field strength, Permeability, Reluctance. 3.2 Magnetic leakage, leakage coefficient 3.3 Magnetic Hysteresis, Hysteresis loop, 3.4 Magnetization (B-H) Curve 3.5 Analogy between electric and magnetic circuits 3.6 Electromagnetism 3.7 Induced e.m.f -Statically (self and mutual) and dynamically induced emf, 3.8 Faraday's Laws of electromagnetic Induction. 3.9 Lenz's Law, Fleming's R.H. rule; direction of induced E.M.F, Fleming's L.H. rule, Ampere's Law	**CO2, CO3**
TSO.4.a Describe the construction and working principle of the given type of semiconductor TSO.4.b Describe the principle of the given type of semiconductor. TSO.4.c Describe between the given type insulator, conductor and semiconductor based on energy band theory. TSO.4.d Describe working principle, characteristics and application of the given type of diode. TSO.4.e Describe working principle of the given type of Bipolar Junction Transistor. TSO.4.f Describe working principle of the given type of Field Effect Transistor.	**Unit-4.0 Basic Electronic Components** 4.1 Semiconductors: Definition, types of semiconductors and their materials. Energy band theory and effect of temperature. 4.2 Diodes: Basic Concept of Diodes, N-type & p-type PN Junction Diode – Forward and Reverse Bias Characteristics i.e., PN junction Barrier voltage, depletion region, Junction Capacitance. Forward biased & reversed biased junction, Diode symbol 4.3 Bipolar Junction Transistor (BJT): NPN and PNP Transistor – Operation and characteristics. symbol 4.4 Field Effect Transistor (FET): FET – Operation and characteristics, Classification FET and advantages, FET symbol	**CO4**
TSO.5a Convert one number system to other number system. TSO.5b Use Boolean Algebra to solve expressions TSO.5c Implement Boolean expressions for given logic gates	**Unit-5.0 Overview of Digital Electronics** 5.1 Introduction to different Number systems: Binary, Octal, Decimal & Hexadecimal & their Conversion from one another 5.2 Introduction to Boolean Algebra, rules and Laws of Boolean Algebra – DE Morgan's Law 5.3 Study of logic gates (NOT, OR, NOR, AND, NAND) Symbolic representation, Truth Table and Implementation of Boolean expressions	**CO4, CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2420103

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 1.1 Classify given electrical components in to Resistor, Inductor and Capacitor.	1.	Classification of electrical components	CO1
LSO 1.2 Plot the terminal voltage of a source starting from no load to different load (Current) conditions	2.	Terminal voltage of a source for different load conditions	CO1
LSO 1.3 Measure current and voltage in a branch of the given electric circuit	3.	Measurement of current and voltage in a branch of the electric circuit	CO1
LSO 1.4 Verify the zero Phase difference between current and voltage waveform for a resistor connected to an AC source with respect to time (using CRO).	4.	Phase difference between voltage and current waveform in a given resistor using CRO	CO1
LSO 1.5 Calculate the value of color-coded resistor and verify it by measuring the value of resistor using digital multimeter	5.	Value of color-coded resistor	CO1
LSO 1.6 Measure resistance in an series and parallel combination of resistors using digital multimeter	6.	Measurement of resistances in series and combination in an electric circuit.	CO1
LSO 1.7 Calculate the value of equivalent capacitance in series and parallel combination and verify by measuring the value of capacitance using digital multimeter	7.	Measurement of capacitance in series and parallel combination of Capacitors.	CO1
LSO 2.1 Apply ohm's law to calculate voltage across each element in a given circuit	8.	Measurement of voltage across each element of the given linear circuit	CO1, CO2
LSO 2.2 Determine currents using KCL in a given electric circuit and verify it by conducting experiment	9.	Measurement of current in the given electric circuit.	CO1, CO2
LSO 2.3 Determine voltages using KVL in a given electric circuit and verify it by conducting experiment	10.	Measurement of voltage in a given electric circuit	CO1, CO2
LSO 2.4 Verify the Phase difference (Lag) between current and voltage waveform for an inductor connected to an AC source with respect to time using CRO.	11.	Phase difference(lag) between voltage and current waveform in a given inductor	CO1, CO2
LSO 2.5 Verify the Phase difference(lead) between current and voltage waveform for a capacitor connected to an AC source with respect to time using CRO.	12.	Phase difference(lead) between voltage and current waveform in a given capacitor using CRO	CO1, CO2
LSO 2.6 Perform experiment to plot BH curve in a magnetic material	13.	BH curve of a given magnetic material	CO1, CO2
LSO 3.1 Perform experiment to demonstrate statically and dynamically induced emf.	14.	Statically and Dynamically induced emf.	CO2, CO3
LSO 3.2 Perform experiment to demonstrate self and mutual inductance.	15.	Self and Mutual inductance.	CO2, CO3
LSO 3.3 Perform experiment to demonstrate Faraday's laws of electromagnetism	16.	Faraday's laws of electromagnetism.	CO2, CO3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 3.4 Perform experiment to demonstrate Flemings right hand and left-hand rules	17.	Flemings right hand and left-hand rules.	CO2, CO3
LSO 3.5 Perform experiment to demonstrate Lenz's law	18.	Lenz's law.	CO2, CO3
LSO 4.1 Test the working of a given diode, and plot the labelled V-I characteristics	19.	VI characteristics of Diode.	CO4
LSO 4.2 Test the working of a given BJT and plot the labelled V-I characteristics.	20.	VI characteristics of BJT.	CO4
LSO 4.3 Test the working of a given FET and plot the labelled V-I characteristics	21.	VI characteristics of FET	CO4
LSO 5.1 Build and verify the truth tables for all logic gates – NOT, OR, NOR, AND, NAND	22.	Logic Gates – NOT, OR, NOR, AND, NAND	CO5

L) Suggested Term Work and Self-Learning: S2420103 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.

i. Prepare a report on comparison of a physical system (containing two vertical water columns connected with a horizontal capillary tube and liquid flow due to gravity) to demonstrate the analogy of charge, potential difference and current flow in electrical system.
ii. Prepare a report on types of resistors, their power ratings and relevant applications.
iii. Calculate resistance value of a given resistor based on color codes and verify its value using multimeter.
iv. Prepare a chart showing range of resistances used for electrical insulating materials.
v. Sketch a plot of BH curve for soft and hard magnetic materials respectively.
vi. Collect the information regarding various types of inductors used in different domestic appliances.
vii. Prepare a chart of different types of capacitors used with their applications.
viii. Prepare a chart illustrating an example to differentiate between useful and leakage flux.

b. Micro Projects:

1. Demonstrate the working of resistor, Inductor and Capacitor through role play or using animation
2. Prepare detailed specifications of a typical capacitor bank used for power factor improvement in an industry.
3. Prepare a chart for commonly used capacitors used in different domestic appliances (name of appliances with type and ratings)
4. Build and test the capacitor and choke in a fluorescent lamp for its proper working.
5. Connect three chokes in series and 40 Watt lamp in series with a switch across a single phase AC supply. Analyze the effect of switching action and comment on variation of voltage and current with respect to time.
6. Search animations demonstrating Faraday's laws of electromagnetic induction and Lenz's law to understand the concepts of electromagnetic induction and develop a presentation
7. Prepare a report on the comparison of technical parameters of NPN and PNP transistor.
8. Build and test the transistor switch circuit.
9. Build the logic gates and verify the truth table

c. Other Activities:

1. Seminar Topics:
   - Types of resistors, Inductors and capacitors and their application
   - Basic laws governing DC and AC circuits
   - Applications based on principle of electromagnetic induction.

2. Surveys:
   - Carry out a market survey for availability of different types of resistors used for small projects.
   - Survey a market for availability of different types of semiconductor diodes used for small projects.

3. Visit:
   - Visit institute laboratory/workshop and prepare report about the various electrical sources available along with their specifications.
   - Visit to a nearby electrical substation and observe the capacitors installed

d. Self-Learning Topics:

- Industrial/commercial applications of AC and DC supply
- Differentiate between AC and DC in terms of generation, waveforms, and power
- Conduct a literature survey and prepare list of materials (conducting, insulating, magnetic) and their corresponding applications commonly used in electrical system.
- Applications of statically and dynamically induced emf
- Different types of CROs available in the market
- Different types of Multimeter available in the market

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional 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)**		Sessional Work Assessment (SWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	20%	20%	33%	20%	20%
CO-2	20%	25%	20%	20%	33%	25%	20%
CO-3	25%	25%	20%	20%	34%	20%	20%
CO-4	25%	20%	20%	20%	--	20%	20%
CO-5	15%	15%	20%	20%	--	15%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

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

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

#: Mentioned under point-(O)

Note:

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

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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 Basic Electrical parameters and concepts	8	CO1	11	4	4	3
Unit-.2.0 Fundamentals of DC and AC circuits	12	CO2	17	4	6	7
Unit-.3.0 Magnetic circuits and electromagnetic induction	10	CO3	17	4	6	7
Unit-.4.0 Basic electronic components	10	CO4	14	4	6	4
Unit-.5.0 Overview of Digital electronics	8	CO5	11	4	3	4
Total Marks	**48**	**-**	**70**	**20**	**25**	**25**

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

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1.	Classification of electrical components	CO1	50	40	10
2.	Terminal voltage of a source for different load conditions	CO1	50	40	10
3.	Measurement of current and voltage in a branch of the electric circuit	CO1	50	40	10
4.	Phase difference between voltage and current waveform in a given resistor using CRO	CO1	45	45	10
5.	Value of color-coded resistor	CO1	50	40	10
6.	Measurement of resistances in series and combination in an electric circuit.	CO1	50	40	10
7.	Measurement of capacitance in series and parallel combination of Capacitors.	CO1	50	40	10
8.	Measurement of voltage across each element of the given linear circuit	CO1, CO2	50	40	10
9.	Measurement of current in the given electric circuit.	CO1, CO2	50	40	10
10.	Measurement of voltage in a given electric circuit.	CO1, CO2	50	40	10
11.	Phase difference(lag) between voltage and current waveform in a given inductor.	CO1, CO2	50	40	10
12.	Phase difference(lead) between voltage and current waveform in a given capacitor using CRO.	CO1, CO2	50	40	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
13.	BH curve of a given magnetic material.	CO1, CO2	50	40	10
14.	Statically and Dynamically induced emf.	CO2, CO3	50	40	10
15.	Self and Mutual inductance.	CO2, CO3	50	40	10
16.	Faraday's laws of electromagnetism.	CO2, CO3	50	40	10
17.	Flemings right hand and left-hand rules.	CO2, CO3	50	40	10
18.	Lenz's law.	CO2, CO3	60	30	10
19.	VI characteristics of Diode.	CO4	60	30	10
20.	VI characteristics of BJT.	CO4	60	30	10
21.	VI characteristics of FET.	CO4	60	30	10
22.	Logic Gates – NOT, OR, NOR, AND, NAND	CO4	50	40	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.

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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.	DC Source (Variable)	0-20/50 Volts	1-18
2.	AC Source (Variable)	0-300 Volts	1-18
3.	Voltmeter	0-300 V, 0-75 V (MI & MC)	1-18
4.	Ammeter	0-5/10/20 A (MI), 0-2 A (MC)	1-18
5.	Rheostats	0-50 Ohms, 5 Amp; 0-300 Ohms, 2 amp	1-18
6.	Resistors, Capacitors, and Inductors	Appropriate ratings and different types	1, 6
7.	Demonstration kit for demonstrating statically and dynamically induced emf	Lab experiment purpose	14
8.	Demonstration kit to demonstrate self and mutual inductance.	Lab experiment purpose	15
9.	Demonstration kit for Faraday's laws of electromagnetic induction.	Lab experiment purpose	16
10.	Demonstration kit for Flemings right hand and left hand rules.	Lab experiment purpose	17
11.	Demonstration kit for Lenz's law.	Lab experiment purpose	18
12.	Multimeter	Digital Multimeter: 3 1/2-digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000V max), A_{dc}, A_{ac} (10 amp max), Resistance: (0 - 100 M∧), Capacitance and Temperature measurement	5,7,19,20,21,22
13.	Electronic Work Bench	Bread Board 840 -1000 contact points: Positive and Negative power rails on opposite side of the board, 0-30 V, 2 Amp Variable DC power supply, Function Generator 0-2MHz, CRO: 0-30 MHz, Digital Multimeter	19,20,21,22
14.	CRO dual trace	25 MHz,230 V AC, 50 Hz	4,12,19,20,21,22
15.	Electronic components Connecting probes	PN diode -NPN and PNP, BJT, FET, Logic gates OR, AND, NOT, NOR, NAND Connecting probes -1 set	19,20,21,22

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Basic Electrical Engineering	Mittle and Mittal	McGraw Education, New Delhi, 2015, ISBN: 978-0-07-0088572-5
2.	Fundamentals of Electrical Engineering	Saxena, S. B. Lai	Cambridge University Press, ISBN: 9781107464353
3.	Electrical Technology Vol- I	Theraja, B. L.	S. Chand Publications, New Delhi. 2015, ISBN: 9788121924405
4.	Basic Electrical and Electronics Engineering	Jegathesan, V.	Wiley India, New Delhi, 2015, ISBN: 97881236529513
5.	Principles of Electronics	Mehta, V.K.; Mehta, Rohit	S. Chand and Company, Ram Nagar, New Delhi-110 055, 504, 2014, ISBN: 9788121924
6.	Basic Electronic Engineering	Baru V.; Kaduskar R.; Gaikwad S.T.	Dream tech Press, New Delhi, 2015, ISBN: 9789350040126

(b) Open Educational Resources (OER):

1. https://onlinecourses.nptel.ac.in/noc20_ee64/preview
2. https://archive.nptel.ac.in/courses/108/108/108108076/
3. https://nptel.ac.in/courses/122106025
4. https://www.youtube.com/watch?v=Zr2SxTiKUCM&list=PLJvKqQx2Atc61XCOHXm_ACNkOkAm3yO4 &index=4
5. https://www.youtube.com/watch?v=9LNRAwf3uqs
6. https://de-iitr.vlabs.ac.in/List%20of%20experiments.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. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

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A) Course Code : **2425103(T2425103/P2425103/S2425103)**

B) Course Title : Fundamentals of Mechanical Engineering (CE, CHE, CRE)

C) Pre- requisite Course(s) :

D) Rationale :

Now a days as an advancement of technology interdisciplinary knowledge is must for the engineering diploma holders. An engineering diploma holder expected to look after many activities at work place, which may be of interdisciplinary. Knowledge other than own discipline plays important role in the development of individual as well as society. This course mainly encompasses the major areas of mechanical engineering which are being used by engineering diploma holders and are required to perform tasks such as selection of hand tools, power tools, welding, cutting, manufacturing processes, IC engines, refrigeration and air conditioning and power transmission drives used for various purposes. Such skills can be developed by knowing the basic principles of mechanical engineering. The motive of this subject is to enhance the knowledge & skill level in the interdisciplinary area. This course is designed in such a way that practical performed in this course will develop these basic skills to perform well in industry as well as in field work.

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.** Interpret laws of thermodynamics
- **CO-2.** Calculate brake thermal efficiency for the given data of an IC engines.
- **CO-3.** Select relevant material and mechanical tools for a given job.
- **CO-4.** Use relevant manufacturing process for a given component.
- **CO-5.** Select relevant power transmission drives in real life 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	2	1	-	1	-	1		
CO-2	3	2	1	-	1	-	1		
CO-3	3	2	1	-	1	-	1		
CO-4	3	2	1	-	1	-	1		
CO-5	3	2	1	-	1	-	1		

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2425103	Fundamental of Mechanical Engineering	03	-	04	02	09	06

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment(LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2425103	Fundamentals of Mechanical Engineering	30	70	20	30	20	30	200

Legend:

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

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

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

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, 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: T2425103

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the role of thermodynamics in engineering. *TSO 1b.* Explain thermodynamics systems and its types. *TSO 1c.* Interpret laws of thermodynamics *TSO 1d.* Describe thermodynamic properties, process and cycle *TSO 1e.* Describe different modes of Heat transfer. *TSO 1f.* Use modes of heat transfer for the given situation.	**Unit-1.0 Introduction to Thermodynamics** 1.1 Role of thermodynamics in engineering and science, 1.2 Types of thermodynamics systems 1.3 Specific volume, enthalpy, pressure, temperature, thermodynamic work thermodynamic equilibrium 1.4 First law, second law and zeroth of thermodynamics 1.5 Enthalpy of wet steam, superheated steam, dryness fraction, degree of superheat 1.6 Modes of heat transfer: conduction-composite walls, combined conduction, convection, radiation, application of heat transfer modes	**CO1**
TSO.2a Differentiate between two stroke and four stroke engines *TSO.2b* Describe construction and working of a given diesel engine. *TSO.2c* Describe construction and working of a given petrol engine *TSO.2d* Calculate brake thermal efficiency of an IC engines. *TSO.2e* Identify simple faults in the given engine. *TSO.2f* Suggest remedial measures to rectify the given fault *TSO.2g* Calculate coefficient of performance and of tonnage capacity of an air conditioning system *TSO.2h* Explain construction and working of a given refrigeration system. *TSO.2i* Describe the troubleshooting procedure of a given refrigeration system and air-conditioning system.	**Unit-2.0 Internal Combustion Engine and Refrigeration** 2.1 Types of internal combustion engines- S.I. and C.I. Engines, 2.2 Construction and working two stroke and four stroke petrol engines and two stroke and four stroke diesel engines 2.3 BP, heat supplied and brake thermal efficiency of IC engines. 2.4 Common faults in IC engines, remedial measures to rectify the faults 2.5 **Air pollution** due to IC engines. 2.6 Heat engine, concept of refrigeration, ton of refrigeration, unit of refrigeration, COP 2.7 Major components of vapor compression systems, heat pump, Carnot cycle, Carnot efficiency, 2.8 Types of refrigerants 2.9 Types of air conditioning systems - window, package, central air-conditioning systems 2.10 Domestic refrigerator. 2.11 Basic fault finding in refrigerator and window air-conditioner. 2.12 Methods of energy saving in refrigeration and air-conditioning systems.	**CO2**
TSO 3a. Classify engineering materials. *TSO 3b.* Select engineering materials as per the given situation	**Unit-3.0 Engineering Materials** Introduction to engineering materials, classification of materials 3.1 **Metallic materials**	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3c. Describe different properties of the given material. *TSO 3d.* Identify the properties of a given material. *TSO 3e.* Differentiate between metallic and nonmetallic material	• Ferrous alloys- carbon steel, low-alloy steel, tool steel, stainless steel, cast iron • Aluminum alloys, nickel alloys, copper alloys, titanium alloys, • Magnetic, dielectric and superconducting materials 3.2 **Non-metallic materials** • Ceramics – types and applications • Polymers-thermoplastic polymers, thermosetting polymers, elastomers • Metallic glasses: types, glass forming ability of alloys, melt spinning process • Composites-particulate composites, fibrous composites, laminated composites 3.3 **Mechanical properties** Tensile strength, elasticity, plasticity, hardness, toughness, brittleness stiffness, ductility, malleability, cohesion, impact strength, fatigue, creep, hooke's law, poisson's ratio 3.4 **Magnetic properties of materials** Intensity of magnetization, magnetic field (h) or magnetic intensity, magnetic susceptibility, retentivity, coercivity 3.5 **Optical properties of materials-** elastic properties of materials, dielectric properties of materials 3.6 **Physical properties of materials** Electrical conductivity, melting temperature of material, semiconductors, thermal conductivity, fusibility, reluctance (as magnetic properties), density, melting point and boiling point.	
TSO.4a Select machine tool as per the given job. *TSO.4b* Use machine tools for the given job. *TSO.4c* Explain different operation performed on the given machine tool. *TSO.4d* Select welding equipment for the given job *TSO.4e* Explain working of arc and gas welding *TSO.4f* Explain brazing and soldering process *TSO.4g* Describe the procedure for casting of given job. *TSO.4h* Explain concept of various metal forming processes. *TSO.4i* Identify metal forming process for the given job.	**Unit-4.0 Manufacturing Processes and Machine Tools** 4.1 Basic machine tools. • Introduction to lathe, drill, milling and grinding machines. • Types of operations / jobs which can be performed on machine tools listed above. 4.2 Metal joining processes. • Welding-types, working setup of arc and gas welding, precautions and safety during arc and gas welding. • Brazing and soldering-general set up, applications. 4.3 Foundry- concept, process of casting a component, applications.	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.4j Prepare a simple job with ABS material using 3D printer *TSO.4k* Select suitable 3D Printer and software for the given application with justification.	4.4 Basic metal forming processes-bending, rolling, forging and extrusion –concept and its application 4.5 Additive manufacturing techniques-introduction to various additive manufacturing processes-stereo-lithography, LOM, FDM, SLS, SLM, Binder Jet technology, Direct Energy Deposition 4.6 FDM based 3D printer, its working and construction, Process parameters	
TSO 5a. Identify different mode of power transmission. *TSO 5b.* Select suitable power transmission mode for given application. *TSO 5c.* Identify the different types of Brake, Clutch and Coupling. *TSO 5d.* Explain with sketches construction and working of given brake, clutch and coupling *TSO 5e.* Explain the types of belts and its velocity ratio.	**Unit-5.0 Power Transmission** 5.1 Belt drives - flat belt and v– belt drive, ropes and chain, velocity ratio slip, length of the belt, open belt and cross belt drives the ratio of friction tensions, centrifugal tension in a belt Power transmitted by belts and ropes Initial tensions in the belt 5.2 Gear drives-classification, simple, compound – reverted and epicyclic gear trains, their selection for different applications, gear trains velocity ratio, velocity ratio, gear ratio, 5.3 Couplings- muff coupling and flange coupling joints-cotter joint and knuckle joint 5.4 Helical springs (closed and open coil) 5.5 Friction clutches: single plate, multi plate, cone clutch, variable speed clutch, positive drive clutches: claw and jaw clutch. (construction and working) 5.6 Brakes: shoe brake, internal expanding and disc brakes. (construction and working) 5.7 Fasteners: keys, nut-bolt connections, screws, rivets	**CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2425103

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Calculate thermal conductivity for thick &composite slab	*1*	Determine the thermal conductivity of a thick slab	CO1
	2	Determine the thermal conductivity of Composite Wall.	CO1
LSO 2.1. Dismantle and assemble given engines	*3*	Dismantle and Assemble two stroke and four stroke petrol engines.	CO2
LSO 2.2. Identify the various component in IC engines	*4*	Identify the various processes and components of two stroke and four stroke petrol engines.	CO2
LSO 2.3. Use trainer to Design and assemble given circuit	*5*	Design and assemble a circuit that extends and retracts a single acting (spring return) and double acting cylinder on a given trainer.	CO2
LSO 2.4. Determine the properties and coefficient of performance.	*6*	Determine properties of air (Dry bulb temperature, Wet bulb temperature, Humidity)	CO2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
	7	Determine of coefficient of performance and of tonnage capacity of an Air conditioning system	CO2
LSO 2.5. Identify components of refrigeration system.	*8*	Identify the components of refrigeration system and air conditioning system	CO2
LSO 3.1. Identify the microstructure of different materials	*9*	Use microscope to identify microstructure of material	CO3
LSO 3.2. Use hardness testing machine	*10*	Measure hardness of given material using given hardness tester.	CO3
LSO 3.3. Use tensile testing machine	*11*	Measure tensile strength of given metallic materials using tensile test method.	CO3
	12	Determination of tensile properties of composite	CO3
LSO 3.4. Use compressive testing material	*13*	Determination of compressive properties and shear properties of unidirectional lamina	CO3
LSO 3.5. Use charpy impact machine	*14*	Use the charpy impact test to measure the values of the impact energy (also called notch toughness) of steel samples.	CO3
LSOs 4.1 Use lathe machine	*15*	Prepare a plain turning and taper turning job as per the given drawing.	CO4
LSOs 4.2 Use milling machine	*16*	Prepare a job on the milling machine as per the given drawing.	CO4
LSOs 4.3 Use of gas & arc welding for given metal.	*17*	Perform gas welding operation on the given job.	CO4
	18	Perform arc welding operation on the given job	CO4
LSOs 4.4 Use soldering and brazing equipment	*19*	Perform soldering and brazing operation on the given job.	CO4
LSOs 4.5 Use sheet metal operation for the given job.	*20*	Prepare a sheet metal product (Funnel) and report the various parameters for the various passes during the rolling of the given metal piece.	CO4
LSOs 4.6 Use different foundry tools and equipment's	*21*	Select different foundry tools and equipment's for a given job	CO4
LSOs 4.7 Prepare sand mold	*22*	Identify various stages of casting through demonstration of Sand-Casting Process.	CO4
	23	Prepare of a sand mold with a simple pattern	CO4
LSOs 4.8 Prepare solid pattern	*24*	Produce wooden solid pattern as per given drawings.	CO4
LSOs 4.9 Produce a component using available 3D printer	*25*	Print one single component on available 3D printer with PLA/ABS material	CO4
LSO 5.1. Identify the various component in Clutches.	*26*	Dismantle and assemble different clutches as per the given instruction	CO5
LSO 5.2. Select different drives for the given job	*27*	Use belt, chain and gear drive for the given job.	CO5
LSO 5.3. Determine velocity ratio of given drives	*28*	Calculate the velocity ratio for given compound gear train	CO5
	29	Determine the velocity ratio of a flat belt drive.	CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
	30	Determine the velocity ratio of simple gear drive.	CO5
LSO 5.4. Identify the various component in brakes and couplings	*31*	Dismantle and Assemble different brakes and couplings as per the given instruction	CO5

L) Suggested Term Work and Self Learning: S2425103 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.

i. Calculate the refrigeration capacity of a given room in ton.
ii. Write 05 uses of sheet metal in detail in our daily life
iii. Identify the types of manufacturing process used in a given 10 samples.
iv. Select the power transmitting element for the five situations with reason.
v. Draw and Study circuit diagram for starting motor of IC engines and Battery Ignition system.
vi. Collect videos, animations showing working of different types of air compressors.
vii. Make a troubleshooting chart for Domestic refrigerators.
viii. Collect manufacturer's specifications for various refrigeration controls.

b. Micro Projects:

i. Print two pieces of same components using ABS and PLA and compare their strength, surface roughness, weight, cost.
ii. Build model of different gears from cardboard.
iii. Build model of IC Engine parts from cardboard.
iv. Prepare cast product with wax material
v. Make models of controls demonstrating their functions at least 3 under guidance of instructor/teacher in lab/ workshop.
vi. Prepare a given product using arc welding/gas welding.
vii. Market survey on gears and collect information of different types of gear used in machine equipment, prepare a chart showing different gears and its uses.
viii. Prepare a report on refrigerant used in domestic refrigeration, car refrigeration system etc.
ix. Prepare a report on emission of petrol engine and diesel engine.

c. Other Activities:

1. Seminar Topics:
   - Refrigerants used in Commercial air conditioning & Refrigeration system
   - Properties of PLA and ABS 3D printing materials.
   - Sheet metal operations and its application.
   - Recent advancement in brake and its advantages.
   - Classification of engineering materials and its properties.
   - Application of solar energy as a power source.
   - Future scope of **renewable energy** source as power generation system.

2. Visits:
   - Visit nearby workshop/industry with sheet metal facilities. Prepare report of visit with special comments on different operation performed and material used in production.
   - Visit nearby workshop/industry with welding facilities. Prepare report of visit with special comments on different joining process used and material.
   - Visit a nearby dairy plant and prepare a report on process involve in storage of diary product.
   - Visit a nearby power plant and prepare a report on step involve/equipment used in power generation.
   - Visit nearby tool room/industry with 3D Printing facilities. Prepare report of visit with special comments of 3D printing technique used, material used, single component/batch production/mass production and cost of printed component.

3. Self-Learning Topics:
   - 3D printing of micro/mini components.
   - Conversion of CAD file formats into IGES.
   - Types of nut-bolt/coupling devices/rivets used in industry.
   - Refrigerant used in commercially available refrigeration and air conditioning system.
   - Different types of energy sources available in India.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	12%	15%	-	-	20%	20%
CO-2	10%	22%	10%	25%	-	10%	20%
CO-3	15%	22%	15%	25%	33%	15%	20%
CO-4	30%	22%	30%	25%	33%	15%	20%
CO-5	30%	22%	30%	25%	34%	40%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application& above (A)
Unit-1.0 Introduction to Thermodynamics	9	CO1	10	4	4	2
Unit-2. 0 Internal Combustion Engine and Refrigeration	10	CO2	15	4	6	5
Unit-3.0 Engineering Materials	9	CO3	15	4	5	6
Unit-4.0 Manufacturing Processes and Machine Tool	10	CO4	15	4	5	6
Unit-5.0 Power Transmission	10	CO5	15	4	4	7
Total Marks	**48**	-	**70**	**20**	**24**	**26**

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

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1	Determine the thermal conductivity of a thick slab	CO1	40	50	10
2	Determine the thermal conductivity of Composite Wall.	CO1	40	50	10
3	Dismantle and Assemble two stroke and four stroke petrol engines.	CO2	40	50	10
4	Identify the various processes and components of two stroke and four stroke petrol engines.	CO2	40	50	10
5	Design and assemble a circuit that extends and retracts a single acting (spring return) and double acting cylinder on a given trainer.	CO2	40	50	10
6	Determine properties of air (Dry bulb temperature, Wet bulb temperature, Humidity)	CO2	40	50	10
7	Determine of coefficient of performance and of tonnage capacity of an Air conditioning system	CO2	40	50	10
8	Identify the components of refrigeration system and air conditioning system	CO2	40	50	10
9	Use microscope to identify microstructure of material	CO3	40	50	10
10	Measure hardness of given material using given hardness tester.	CO3	40	50	10
11	Measure tensile strength of given metallic materials using tensile test method.	CO3	40	50	10
12	Determination of tensile properties of composite	CO3	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
13	Determination of compressive properties and shear properties of unidirectional lamina	CO3	40	50	10
14	Use the charpy impact test to measure the values of the impact energy (also called notch toughness) of steel samples.	CO3	40	50	10
15	Prepare a plain turning and taper turning job as per the given drawing.	CO4	40	50	10
16	Prepare a job on the milling machine as per the given drawing.	CO4	40	50	10
17	Perform gas welding operation on the given job.	CO4	40	50	10
18	Perform arc welding operation on the given job	CO4	40	50	10
19	Perform soldering and brazing operation on the given job.	CO4	40	50	10
20	Prepare a sheet metal product (Funnel) and report the various parameters for the various passes during the rolling of the given metal piece.	CO4	40	50	10
21	Select different foundry tools and equipment's for a given job	CO4	40	50	10
22	Identify various stages of casting through demonstration of Sand-Casting Process.	CO4	40	50	10
23	Prepare sand mold with a simple pattern	CO4	40	50	10
24	Produce wooden solid pattern as per given drawings.	CO4	40	50	10
25	Print one single component on available 3D printer with PLA/ABS material	CO4	40	50	10
26	Dismantle and assemble different clutches as per the given instruction	CO5	40	50	10
27	Use belt, chain and gear drive for the given job.	CO5	40	50	10
28	Calculate the velocity ratio for given compound gear train	CO5	40	50	10
29	Determine the velocity ratio of a flat belt drive.	CO5	40	50	10
30	Determine the velocity ratio of simple gear drive.	CO5	40	50	10
31	Dismantle and Assemble different brakes and couplings as per the given instruction	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.	Experimental setup for the measurement of thermal conductivity of thick slab and composite wall	Guarded Hot Box, Solar Calorimeter, Large Diameter Integrating Sphere, Environmental Chambers, Heat Flow Meters, Computer Simulation Software, Guarded Hot Plate (ASTM C177), Guarded-Comparative–Longitudinal Heat Flow Meter, Comparative-axial-heat-flow (cut-bar) Method, Transient Hot Wire, Laser Flash Diffusivity	1,2
2.	Single cylinder two stroke petrol engine	Two stroke single cylinder horizontal petrol engine Power:3- 4.5 HP, Speed: 4000-6000 rpm, bore: 70-80 mm, stroke length:66.7-70mm, starting: rope & self-starting, working cycle: four strokes, Engine cooling: forced air cooled, V C R head cooling: water cooled, Method of ignition: spark ignition, Orifice dia: 20mm, Compression ratio: 2.5:1 to 8:1, Spark plug	3,4
3.	Single cylinder four stroke diesel engine test rig	Bore: 85-90 mm, Stroke: 80-85 mm, RPM: 1500-1700, BHP: 5 -5.5 HP, 3.7 KW, Fuel: High Speed Diesel oil, Sp. Gr.: 0.83, C.V: 10,833 Kcal/k	3,4
4.	Single cylinder four stroke petrol engine test rig	Four stroke single cylinder vertical petrol engine Power: 2.9 KW, Speed: 3000 -4000 rpm, Air cooled Engine, Bore: 70-75mm, Stroke: 66.7-7 mm, Capacity: 256 cc, Fuel: Petrol, Sp. Gr: 0.71	3,4
5.	Pneumatic trainer and hydraulic trainer	Pneumatic and hydraulic trainer	5
6.	Air conditioning system test rig	Compressor unit, condenser, evaporator, cooling chamber, controlling and measuring instrument control panel	7
7.	Refrigeration system test rig	Compressor unit, condenser, evaporator, cooling chamber, controlling and measuring instrument control panel	8
8.	Hardness testing machine	• **Rockwell harness tester** - JIS B 7726 ISO 6508-2 ASTM E18-10, preliminary test force 98.07N (10kgf), 29.42 (3kgf) Manual (with automatic brake-start), Test Force Rockwell- 588.4N (60kgf), 980.7N (100kgf), 1471N (150kgf) Automatic (loading, duration) Maximum Specimen Ht. 7.1-7.5", Maximum Depth 6.5-7" • **Brinell hardness tester**- Brinell scale load range of 612N – 29.42 KN (62.5 kgf – 3000 kgf.), display- Hardness HB value (after entering diagonal length into keypad calculator); Mean diagonal length; Test force; Dwell time; Ball diameter; Conversion; Limits, hardness Resolution 0.1 unit if HB < 100; else 1.0 unit, Standards Compliant ISO 6506, ASTM E10, JIS, Test Load Type -Load Cell Closed-Loop Control System, Test Cycle-Automatic, Test Loads-62.5, 187.5, 250, 500, 750, 1000, 1500, 3000kgf	10

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
9.	Tensile testing machine	Motor: ¼ HP Single Phase 220 / 110 V AC Supply Speed: 100 mm/min and 200 mm/min (Changeable through Belt & Pulley mechanism), Display: Digital (LED), Accuracy: ± 2% at Full Load (with master load) Grip to Grip separation: Min 25mm and Max. 700mm	11,12
10.	Compressive testing machine	1000 KN - for load cell calibration - fully automatic - servo controlled	13
11.	Impact testing machine	Impact tester should confirm to the Standards: ASTM D 256 & ASTM D 6110, ISO 180 & ISO 179, Microprocessor Controlled equipment with possibility to modify and create test parameters according to standard and store templates, Possibility to save data and export selected data with customized format, Real time display of impact energy, resilience, pendulum angle, impact speed and statistical analysis Pendulum Impact Energy Range- 0-25 Joules, Least Count of Indication- 0.01 Joules, Release Angle of Pendulum -150˚, Striking velocity range of Pendulum -2.5 – 3.8 m/s, Hammers -Hammers for Izod Impact Tests –2.75 J, 5.5 J,11.0 J ,Hammers for Charpy Impact Tests – 1.0 J, 2.7 J, 5.4 J (ASTM D 6110), Hard chrome plated vice , Notch cutting device, Digital Notch depth measuring device (0 to 12 mm), specimens for Izod & Charpy impact test as per ASTM & ISO specification, Motor driven, attached with constant profile tungsten carbide knife, ”V” notch (45^o), Type A, Type B and Type C Comply to ASTM D 256	14
12.	Hand tools	Different spanners (Wrench), Pliers, Screw drives, Chisel, Hand hacksaw, Hammers.	15,16
13.	Power tools-	Portable Drilling and grinding machine, Electric power saw, portable electric cutter, electric demolition hammer, power screw driver.	15,16
14.	Belt arrangement	Working models of different belts in different arrangement.	27,28
15.	Belt and gear drives	Working models of belt drives, chain and sprocket, various gear drives.	27, 29,30
16.	Cut section models of brakes	Working and cut section models of various types of brake assemblies.	31
17.	Models of clutch	Models (Wooden/Plastic/Metallic) of various clutch (suitable for dismantling)	26
18.	Models of coupling	Models (Wooden/Plastic/Metallic) of various coupling. (suitable for dismantling)	
19.	Center Lath	Medium Duty Lathe Machine, Bed Width-240 to 350 mm, Universal Gear Box Center lathe machine (length between centers:1200mm), Max Spindle Speed-1600 to 2000 RPM, Spindle Bore 40 mm to 55 mm, Layout-Horizontal, Automation Grade, Number of Spindle Speeds- 8 to 12, Power 2.2 kW to 5.5 kW, Drive Type-Geared	15
20.	Milling machine	Automatic for Multi-purpose, Table size of Vertical Drive Milling Machine - 325 x 1470 approx, Longitudinal Travel-700-800, Vertical Travel-480-500, cross travel- 350-400, power feed – 700-800, head and ram rotate parallel on body -360-degree, Ram travel – 400-500, Motor, 3 to 3.5 HP, No. of Speeds- 8 Min 75 RPM, Max 3000-4000 RPM	16

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
21.	Arc welding machine	Arc Welding machine welding current 20-400A. Arc welding tools-electrode holder, cable connector, cable lugs, earthing clamp, wire brush.	18
22.	Gas welding machine	Oxygen and acetylene gas welding and cutting kit with cylinders and regulators. welding torch, welding tip, spark lighters.	17
23.	Brazing and soldering kit	Brazing kit with suitable silver and copper brazing alloy rods for ¼ '' to 7/8'' tubes- cu to cu, cu to steel, cu to brass and appropriate flux.)	19
24.	Sheet metal tools	• Cutting Tools- Chisels, Snips or Shears • Striking Tools- Hammers and Punches • Supporting Tools- Stakes, Anvils, Swage Block • Marking and Measuring Tools- Steel rule, Scriber, Trammel, Divider, Swing Blade Protractor, Wire Gauge • Bending and Folding Tools • Other Tools- Grooving Tools, Bench Plate	20
25.	Foundry tools	Hand tools- Hand riddle, Shovel, Rammers- Hand rammer, Peen rammer, Floor rammer, Pneumatic rammers, Sprue pin, strike off bar, Mallet, Draw spike, Vent rod, Lifters, Trowels, Slicks, Smoothers, Swab, Spirit level, Gate cutter, Gaggers, Spray-gun, Nails and wire pieces, Wire pieces, spring and nails, Bellows, Clamps, cotters and wedges Kinds of molding sand- Green sand, Dry sand, Loam sand, facing sand, Backing sand, System sand, Parting sand, Core sand	21
26.	Casting and molding	Hand riddle, Shovel, Rammer, Sprue pin, Strike of bar, Mallet, Draw spike, Vent rod, Lifter, Travels, Slicslick, Smoother, Swabs, Spirit level, Gate cutter, Daggers, Bellows, Clamps, cutters, and wedges	22,23
27.	3D printer	Fused Deposition Modelling system with complete accessories; Build Volume-300 x 300 x 300mm or Higher; Layer Thickness-0.1 – 0.4 OR Available with CoE	25

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Basic Mechanical Engineering	Pravin Kumar	Pearson Education, India, 2018 ISBN: 9789386873293
2.	Basic Mechanical Engineering	S. C. Sharma & M.P. Poonia	Khanna Publishing,2018 ISBN:9789386173331
3.	Theory of machine	R S Khurmi & J K Gupta	Eurasia Publishing House (Pvt.) Ltd. New Delhi,2020, ISBN: 9788121925242
4.	Elements of Mechanical Engineering	Manglik, V. K.	PHI Learning Pvt. Ltd., New Delhi, 2013, ISBN: 9788120346291
5.	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Lan Gibson, David W. Rosen, Brent Stucker	Springer, 2010, ISBN: 9781493921133
6.	Understanding Additive manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing	Andreas Gebhardt,	Hanser Publisher, 2011 ISBN: 156990507X, 9781569905074

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
7.	Manufacturing Technology, Volume-1	P N Rao	McGraw Hill Education, 2018 ISBN-1259062570, 978-1259062575
8.	Manufacturing Technology, Volume-2	P N Rao	McGraw Hill Education, 2018 ISBN-9789353160524, 978-9353160524
9.	Internal Combustion Engines	R.P. Mathur, M.L. & Sharma	Dhanpat Rai Publications ISBN-9383182423
10.	Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution	Liza Wallach Kloski, Nick Kloski	Make Community, LLC; 2nd edition, 2021 ISBN: 9781680450200
11.	3D Printing and Design	Sabrie Soloman	Khanna Publishing House, Delhi, 2020 ISBN: 9789386173768

(b) Online Educational Resources:

1. https://all3dp.com/1/types-of-3d-printers-3d-printing-technology/
2. https://archive.nptel.ac.in/courses/112/103/112103262/
3. http:/nptel.iitm.ac.in/
4. https://www.khanacademy.org/
5. http://learnerstv.in/

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

(c) Others:

1. 3D Printing Projects DK Children; Illustrated edition, 2017
2. Lab Manuals
3. Users guide
4. Material science magazine
5. Manufactures manual

*****

A) Course Code : 2425104(T2425104/P2425104/S2425104)

B) Course Title : Engineering Mechanics
(ELX, ELX (R), TE, CE, ME, EE, ME (Auto), MIE, FTS, AE, CRE, CHE)

C) Pre- requisite Course(s) :

D) Rationale :

In day-to-day working we come across different types of structures created for different purposes and functions, while designing the structures, analysis of forces and stresses' is an important and prerequisite step. Correct analysis is possible only when one knows the types and effects of forces acting on the structures. This course provides the scope to understand fundamental concepts of laws of mechanics and their applications to different engineering problems. This course is designed to provide basic understanding about the different types of forces, moments and their effects on structural elements and to analyze different structural systems. The aim of this course is to help the student to comprehend the importance of applied mechanics and apply the principles of engineering mechanics to solve engineering problems.

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** Compute the force to solve the problems
- **CO-2** Analyse various analytical and graphical conditions required for equilibrium of engineering systems.
- **CO-3** Apply the principles of friction in various conditions to solve problems.
- **CO-4** Calculate centroid, center of gravity and moment of Inertia of different geometrical shapes.
- **CO-5** Select the relevant lifting machine(s) for the given purposes.

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

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				
2425104	Engineering Mechanics	03	-	04	02	09	06

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2425104	Engineering Mechanics	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: T2425104

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain concepts of the given terms. *TSO 1b.* Use relevant units of various quantities in the given situations. *TSO 1c.* Explain effects of a force on the given object. *TSO 1d.* Resolve the given single force. *TSO 1e.* Calculate the resultant of the given force system. *TSO 1f.* Find the resultant of the given force system using law of parallelogram *TSO 1g.* Determine graphically the resultant of the given force system by triangle law and polygon law.	**Unit-1.0 Mechanics and Force System** 1.1 Significance and relevance: Mechanics, applied mechanics, statics and dynamics. 1.2 Space, time, mass, particle, body, rigid body. 1.3 Scalar and vector quantity, Units of measurement (SI units) Fundamental units and derived units. 1.4 Force - unit, representation as a vector and by Bow's notation, characteristics and effects of a force, Principle of transmissibility of force. Force system and its classification. 1.5 Resolution of a force - Orthogonal and Non-Orthogonal components of a force, moment of a force, Avignon's Theorem. 1.6 Composition of forces - Resultant, analytical method of determination of resultant for concurrent, non-concurrent and parallel co-planar force systems -Law of triangle, Law of parallelogram and law of polygon of forces. 1.7 Graphic statics, graphical representation of force, Space diagram, force diagram, polar diagram and funicular polygon, Graphical method of determination of resultant for concurrent and parallel co-planar force systems.	**CO1, CO2**
TSO 2a. Draw the free body diagram for the given condition. *TSO 2b.* Determine unknown force in the given situation using Lami's theorem. *TSO 2c.* Identify the types of beams required for the given situation. *TSO 2d.* Determine reactions in the given type of beam analytically. *TSO 2e.* Solve problems using free body diagram and Lami‟s theorem.	**Unit-2.0 Static Equilibrium** 2.1 Equilibrium and Equilibrant, Free body and Free body diagram, Analytical and graphical conditions of equilibrium. 2.2 Equilibrium of force systems analytically 2.3 Lami's Theorem. 2.4 Types of beam (determinate and indeterminate), supports (simple, hinged, roller and fixed) and loads acting on beam (vertical and inclined point load, distributed load, load, couple), span of beam. 2.5 Beam reaction for cantilever, simply supported beam with or without overhang - subjected to combination of Point load and LTD load or Vertical Point load and couple. 2.6 Beam reaction for simply supported beam subjected to vertical loads only.	**CO1, CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3a. Calculate force of friction and coefficient of friction for the given condition or situation *TSO 3b.* Describe the conditions for friction for the given situation. *TSO 3c.* Identify the various forces acting on a ladder for the given conditions using free body diagram. *TSO 3d.* Compare the value of coefficient of friction between different surfaces. *TSO 3e.* Interpret the effect of change of masses, change of angle of inclination or both on the coefficient of friction *TSO 3f.* Calculate forces acting on a body that is moving on a horizontal rough surface *TSO 3g.* Determine the forces acting on a body that is moving on an inclined plane	**Unit 3.0 Friction** 3.1 Friction and its relevance in engineering, types and laws of friction, limiting equilibrium, limiting friction, co-efficient of friction, angle of friction, angle of repose, relation between co-efficient of friction and angle of friction. 3.2 Equilibrium of bodies on level surface subjected to force parallel and 3.3 inclined to plane. 3.4 Equilibrium of bodies on inclined plane subjected to force parallel to the plane only. FBD of ladder in friction	**CO3, CO4**
TSO 4a. Distinguish between centroid and center of gravity *TSO 4b.* Calculate the centroid of geometrical plane figures. *TSO 4c.* Calculate centroid of the given composite plane lamina *TSO 4d.* Determine centre of gravity of the given simple solid. *TSO 4e.* Determine centre of gravity of the given composite solid. *TSO 4f.* Calculate Moment of Inertia of different geometric shapes.	**Unit 4.0 Centroid, Centre of Gravity and Moment of Inertia** 4.1 Introduction to Centroid, Centre of Gravity and Areas 4.2 Centroid of geometrical plane figures (square, rectangle, triangle, circle, semi-circle, quarter circle). 4.3 Centroid of composite figures composed of not more than three geometrical figures and centroid of perforated section, axis of symmetry 4.4 Centre of Gravity of simple solids (Cube, cuboid, cone, cylinder, sphere, hemisphere). 4.5 Centre of Gravity of composite solids composed of not more than two simple solids. 4.6 Moment of inertia - Introduction, calculation of moment of inertia by integration method, theorem of perpendicular axis, theorem of parallel axis, moment of inertia of a rectangular section, hollow rectangular section, circular section, hollow circular section, triangular section	**CO4**
TSO.5a Describe the components of the given lifting machine. TSO.5b Differentiate the working principle of the given two types of lifting machines. TSO.5c Determine velocity ratio, efficiency of the given lifting machine. TSO.5d Calculate effort required and load lifted by the given lifting machine. TSO.5e Draw the graph with the given data TSO.5f Interpret the given graphs TSO.5g Select the relevant lifting machine for the given purpose with justification	**Unit-5.0 Simple Lifting Machine** 5.1 Simple lifting machine, load, effort, mechanical advantage, Applications and advantages. Velocity ratio, efficiency of machines, Law of machine. 5.2 Ideal machine, friction in machine, maximum Mechanical advantage and efficiency, reversible and non-reversible machines, condition for reversibility 5.3 Velocity ratios of Simple axle and wheel, Differential axle and wheel, Worm and worm wheel, Single purchase and double purchase crab winch, Screw jack, Weston's differential	**CO2, CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	pulley block, geared pulley block. 5.4 Graphs of Load verses Effort, Load verses ideal Effort, Load verses Effort lost in friction, Load verses MA, Load verses Efficiency.	

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2425104

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use force polygon table to determine the resultant of concurrent forces	1.	Determine resultant of concurrent coplanar force system using force polygon table.	CO1, CO2
LSOs 2.1 Apply Lami's theorem LSOs 2.2 Use simply supported beams to find reactions	2.	Determine unknown force in a concurrent balance force system using Lami's Theorem.	CO1, CO2
	3	Find reactions at the supports of a simply supported beam and compare the results with analytical values.	
	4	Determine the support reactions for simply supported beam by • Beam reaction apparatus • Circular dial type weight	
LSO 3.1. Apply law of friction on horizontal plane and inclined plane *LSO 3.2.* Coefficient of friction between different materials *LSO 3.3.* Coefficient of friction between belt and pulley.	5	Determine coefficient of friction on horizontal and inclined plane.	CO2, CO3
	6	Determine the co efficient of friction between two surfaces by • angle of repose methods • friction plane method	
	7	Find the coefficient of friction between belt and pulley in a belt friction set up.	
LSO 4.1. Determine the centroid of different geometrical figures. *LSO 4.2.* Find moment of inertia	8	Determine the centroid of geometrical plane figures (squares, rectangle, triangle)	CO4
	9	Determine the moment of inertia of a fly wheel	
LSOs 5.1 Use simple screw jack *LSOs 5.2* Use differential axle and wheel *LSOs 5.3* Use single and double purchase crab winch *LSOs 5.4* Use jib crane *LSOs 5.5* Use worm and worm wheel apparatus	10	Find M.A, V.R and efficiency of screw jack.	CO5
	11	Find M.A, V.R and efficiency of differential wheel and axle	
	12	Calculate the efficiency of single purchase crab winch and double purchase crab winch	
	13	Determine forces in jib crane.	
	14	Determine the efficiency of worm and worm wheel.	

L) Suggested Term Work and Self Learning: S2425104 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:

- Visit nearby tool room/industry and collect information regarding lifting machine used with their technical specification and their application and prepare comparison chart.
- prepare model of simple lifting machine.
- Prepare models of beam subject to point load, uniformly distributed loads, simply supported, overhang beam.
- Prepare chart showing real-life examples including various types of forces.

c. Other Activities:

1. Seminar Topics:
   - Collision of elastic bodies
   - Law of conservation of energy
   - concept of parallel axis and perpendicular axes theorem

2. Visits: Visit nearby tool room/industry with workshop facilities. Prepare report of visit with special comments of simple lifting machine to be used.

3. Self-Learning Topics:
   - Types of load and beam.
   - Various force system.
   - Simple lifting machine.
   - Centroid of various plane figure

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%	30%	15%	-	-	20%	20%
CO-2	10%	20%	10%	25%	-	10%	20%
CO-3	15%	20%	15%	25%	33%	15%	20%
CO-4	30%	10%	30%	25%	33%	15%	20%
CO-5	30%	20%	30%	25%	34%	40%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

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

Note:

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

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

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Mechanics and force system	14	CO1, CO2	16	5	3	8
Unit-2.0 Static Equilibrium	10	CO1, CO2	14	4	2	8
Unit-3.0 Friction	8	CO2, CO3	14	5	3	6
Unit-4.0 Centroid, Centre of gravity and Moment of Inertia	6	CO4	12	2	2	8
Unit-5.0 Simple lifting machine	10	CO2, CO5	14	4	4	6
Total	**48**	**-**	**70**	**20**	**14**	**36**

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.	Determine resultant of concurrent coplanar force system using force polygon table.	CO1	45	45	10
2.	Determine unknown force in a concurrent balance force system using Lami's Theorem.	CO2	40	50	10
3.	Find reactions at the supports of a simply supported beam and compare the results with analytical values.	CO2	30	60	10
4.	Determine the support reactions for simply supported beam by • Beam reaction apparatus • Circular dial type weight	CO1, CO2	30	60	10
5.	Determine coefficient of friction on horizontal and inclined plane.	CO2, CO3	40	50	10
6.	Determine the co efficient of friction between two surfaces by • Angle of repose method • Friction plane method	CO2, CO3	40	50	10
7.	Find the coefficient of friction between belt and pulley in a belt friction set up.	CO2, CO3	30	60	10
8.	Determine the centroid of geometrical plane figures (squares, rectangle, triangle)	CO4	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
9.	Determine the moment of inertia of a fly wheel	CO4	40	50	10
10.	Find M.A, V.R and efficiency of screw jack.	CO2, CO5	30	60	10
11.	Find M.A, V.R and efficiency of differential wheel and axle	CO2, CO5	30	60	10
12.	Calculate the efficiency of single purchase crab winch and double purchase crab winch	CO2, CO5	30	60	10
13.	Determine forces in jib crane.	CO1, CO2	40	50	10
14.	Determine the efficiency of worm and worm wheel	CO2, 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 and Tools	Broad Specifications	Relevant Experiment/Practical Number
1.	Differential axle and wheel	wall mounted unit with the wheel of 40 cm diameter and axles are insteps of 20 cm and 10 cm reducing diameter	11
2.	Simple screw Jack	Table mounted metallic body, screw with a pitch of 5 mm carrying a double flanged turn table of 20 cm diameter.	10
3.	Worm and worm wheel	wall mounted unit with threaded spindle. load drum. effort wheel: with necessary slotted weights. hanger and thread.	14
4.	Single Purchase Crab winch	Table mounted heavy cast iron body. The wheel is of C.L material of 25 cm diameter mounted on a shaft of about 40mm dia. On the same shaft a geared wheel of 15 cm dia.	12
5.	Double Purchase Crab winch	Having assembly same as above but with double set of gearing arrangement.	11
6.	Weston's Differential pulley block	Consisting of two pulleys; one bigger and other smaller	13
7.	Weston's Differential worm geared pulley block	Consists of a metallic (preferably steel) cogged wheel of about 20 cm along with a protruded load drum of 10 cm dia to suspend the weights of 10 kg, 20 kg-2 weights and a 50 kg weight.	13
8.	Universal Force Table	Consists of a circular 40 cm dia. Aluminum disc. graduated into 360 degrees. with all accessories.	1, 2

S. No.	Name of Equipment and Tools	Broad Specifications	Relevant Experiment/Practical Number
9	Beam Reaction apparatus	The apparatus is with two circular dial type 10 kg.	3,4
10.	Friction apparatus for motion along horizontal and inclined plane	Base to which a sector with graduated arc and vertical scale is provided. The plane may be clamped at any angle up to 45 degrees_ pan. Two weight boxes (each of 5 gm.10 cm, 2-20 gm. 2-50 gm, 2-100 gm, weight.	5,6
11	Set-up for belt friction apparatus	V and Flat Belt, Cap screw, Spring balance, Belt pulley, Torque cord, Load hanger x2, Weights	7
12	Fly wheel apparatus	flywheel, weight hanger with slotted weights, stop clock, metre scale etc	9
13	Jib crane	Jib Apparatus, Weight, Meter Rod, Set Square	13
14	Models of geometrical figures	Models of geometrical figures	8

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Applied Mechanics	R.S. Khurmi	S.Chand &Co. New Delhi 2014 ISBN: 9788121916431
2.	Engineering Mechanics	S. Ramamrutham	S Chand & Co. New Delhi 2008ISBN:9788187433514
3.	Foundations and Applications of Applied Mechanics	H.D. Ram A.K Chauhan	Cambridge University Press. Thomson Press India Ltd., NewDelhi, 2015, ISBN: 9781107499836
4.	Engineering Mechanics- Statics, Vol.1	J.L. Meriam L.G Kraige	Wiley Publication, New Delhi, ISBN: 978-81-265-4396
5.	Applied mechanics	R.K.Rajput	Laxmi publications (p) ltd. ISBN-13: 8105809631
6	Engineering Mechanics	A.R. Basu	TMH Publication, New Delhi
7	Engineering Mechanics	Timosheenko, Young & Rao	TATA McGraw-Hill Education, New Delhi

(b) Online Educational Resources:

1. http://www.asnu.com.au
2. www.youtube.com for videos regarding machines and applications, friction
3. www.nptel.ac.in
4. www.discoveryforengineers.com

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

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A) Course Code : 2400105A(T2400105A/S2400105A)

B) Course Title : Applied Mathematics- A (ME, ME (Auto), CE, MIE, AE, CHE, FTS, CRE)

C) Prerequisite Course(s) : Basic Engineering Mathematics

D) Rationale :

This course is an extension of the course based on Mathematics of the first semester namely Basic Engineering Mathematics. The course is designed to inculcate its application in relevant branches of engineering and technology. With calculus, we can find how the changing conditions of a system affect us, and we can control a system. Definite integral is a powerful tool that helps us realize and model the world around us. Differential equations are widely applied to modern natural phenomena, engineering systems, and many other situations. Numerical methods offer approximate but credible accurate solutions to problems that are not readily or possibly solved by closed-form solution methods. On the other hand, Numerical integration is a computational (approximate) approach to evaluating definite integrals. It has a lot of applications in engineering such as in the computation of areas, volumes, and surfaces. It also has the advantage of being easily programmable in computer software. Probability distributions are useful for modeling, simulation, analysis, and inference on varieties of natural processes and physical phenomena. A situation in which an experiment is repeated a fixed number of times can be modeled, engineers need to apply existing knowledge of success and failure to a specific analytical scenario.

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

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

- **CO-1** Demonstrate the ability to solve engineering-related problems based on applications of integration.
- **CO-2** Develop the ability to use differential equations as a tool to solve problems related to engineering.
- **CO-3** Select a suitable method to solve nonlinear equations based on engineering applications.
- **CO-4** Measure the area and volume of engineering-related problems using the concept of numerical integration.
- **CO-5** Develop the ability to use probability distribution to solve broad-based engineering-related problems.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400105A	Applied Mathematics- A	02	01	-	02	05	04

Legend:

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

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

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

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

SL: Self Learning, MOOCs, Spoken Tutorials, online educational resources, etc.

C: Credits= (1xCIhours) + (0.5xLIhours) + (0.5xNotionalhours)

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400105A	Applied Mathematics- A	30	70	20	30	-	-	150

Legend:

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

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

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, 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 assignments, micro-projects, seminars, 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 for internal as well as external assessment may vary as per the requirement of the respective course. For valid and reliable assessment, the internal faculty should prepare a 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 the 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: T2400105A

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Use standard forms of integration to find the integral of given simple functions. *TSO 1b.* Apply suitable Trigonometric transformation to solve a given Integration problem. *TSO 1c.* Solve given problems using the properties of the definite integral. *TSO 1d.* Invoke the concept of Integration to solve problems based on area and volume of irregular shapes.	**Unit-1.0 Integral Calculus and its Applications** 1.1 Concept and Definition of Integration. 1.2 Working rules and Integral of standard Functions. 1.3 Method of Substitution, Trigonometric transformation, Integration by parts, and Partial fraction. 1.4 Applications: Area and volume	**CO1**
TSO 2a. Find the order and degree of given differential equations. *TSO 2b.* Solve differential equations using the variable separable method. *TSO 2c.* Obtain the solution of a given homogeneous differential equation. *TSO 2d.* Solve the given linear differential equation based on engineering application. *TSO 2e.* Solve the given Bernoulli differential equation. *TSO 2f.* Solve the homogeneous linear differential equations of second order with constant coefficient.	**Unit-2.0 Differential Equations** 2.1 Concept and Definition, Order, and Degree of Differential Equation. 2.2 Differential equation of first order and first degree, variable separable Method. 2.3 Homogeneous, linear Differential equation and Bernoulli equation. 2.4 Homogeneous linear differential equations of second order with constant coefficient.	**CO2**
TSO 3a. Find the root(s) of the given equation using Iterative methods up to the desired accuracy. *TSO 3b.* Calculate the root(s) of given equations using the Newton-Raphson Method. *TSO 3c.* Apply the Newton-Raphson Method for engineering applications. *TSO 3d.* Solve problems using the Bakhshali iterative method for finding approximate square roots. (IKS)	**Unit-3.0 Numerical Solution of Nonlinear Equations** 3.1 Algebraic and Transcendental equations. 3.2 Iteration Methods. 3.3 Newton-Raphson Method. 3.4 Bakhshali iterative method for finding the approximate square root. (IKS)	**CO3**
TSO 4a. Apply the concept of Numerical integration to find the area from given data by the Trapezoidal rule, also use any open source software to find the same. *TSO 4b.* Apply the concept of Numerical integration to find the area from given data by Simpson's one-third rule, also use any open	**Unit-4.0 Numerical Integration** 4.1 Trapezoidal rule 4.2 Simpson's one third rule 4.3 Simpson's three eighth rule	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
source software to find the same by comparing the findings. *TSO 4c.* Apply the concept of Numerical integration to find the area from given data by Simpson's three eight rules, and compare the obtained result with the result found by the analytical method.		
TSO 5a. Select discrete and continuous probability distribution for given data. *TSO 5b.* Solve given problems based on repeated trials using binomial distribution. *TSO 5c.* Use suitable distribution to solve the given problems when the number of trials is large and the probability is very small. *TSO 5d.* Utilize the concept of normal distribution to solve broad-based engineering-related problems.	**Unit-5.0 Probability distribution** 5.1 Discrete and continuous probability distribution. 5.2 Binomial distribution. 5.3 Poisson's distribution. 5.4 Normal distribution.	**CO5**

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

K) Suggested Tutorial and Outcomes: P2400105A

Outcomes	S. No.	Tutorial Titles	Relevant COs Number(s)
1.1 Calculate the area of the hexagon using integration. 1.2 Calculate the average temperature of a city over a certain period. 1.3 Calculate the total force on the bottom of the tank due to the water. 1.4 Estimate the amount of force required to move a component. 1.5 Apply the concept of definite integration to find the volume.	1.	• Area of irregular shape using integration. • Average value of a function using integration. • Calculation of force using integration. • Volume of an irregular shape using integration.	CO1
1.1 Solve population dynamics using first-order ODEs. 1.2 Calculate the vibration of a Mechanical system using differential equations. 1.3 Calculate the concentration of a reactant in a chemical reaction over time. 1.4 Calculate mechanical vibrations using second-order ODEs.	2.	• Analysis of a population model through differential equations. • Response of vibration of Mechanical system through differential equations. • Analysis of chemical system using ODEs • Vibrations of a mass-spring system.	CO2
3.1 Use Newton's method to find the roots of a non-linear equation in one variable. 3.2 Use the concept of Newton's method to solve financial modeling-related problems based on the Black-Scholes model. 3.3 Calculate the electric field (that satisfies Maxwell's equations) around a wire with a	3.	• Applications of iterative techniques. • Application of Newton Raphson's method. • Iterative scheme using Newton's method. • Bakhshali iterative methods for finding the approximate value of square root. (IKS)	CO3

Outcomes	S. No.	Tutorial Titles	Relevant COs Number(s)
given shape and current, using Newton Raphson's method. 3.4 Use Bakhshali iterative methods for finding the approximate value of the square root. (IKS)			
4.1 Use Numerical integration to determine the total quantity of Heat of given a material. 4.2 Use Simpson's 1/3rd rule to find the effective force on the mast of a racing sailboat. 4.3 Apply Numerical integration to calculate work done for a given engineering problem.	4.	• Calculation of Heat (Chemical/Bio Engineering based problem). • Calculation of effective force (Civil/Environment engineering). • Calculation of work done (Mechanical/Aerospace engineering-based problems).	CO4
5.1 Use Binomial distribution to solve the problems when the trials are repeated. 5.2 Use Poisson's distribution to solve the problems when the number of trials is large and the probability is minimal. 5.3 The birth weight follows the normal distribution curve, justified through an example.	5.	• Applications of Binomial distribution. • Applications of Poisson's distribution. • Applications of Normal distribution.	CO5

L) Suggested Term Work and Self-Learning: S2400105A

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

1. Calculate the flow rate of a fluid through a pipe with a given velocity profile using integration through open-source software.
2. Given the plan view of a concrete structure and the desired thickness of the concrete, calculate the area between the curves to determine the surface area of the formwork required.
3. A beam is subjected to a distributed load. The beam has a length of L and a flexural rigidity EI, where E is Young's modulus and I is the moment of Inertia of the beam cross-section. Write down the differential equations that describe the deflection of the beam and solve it to find the deflection equation.
4. Use open-source software to plot the family of curves and compute its differential equations.
5. Write down a program to compute the root of a nonlinear equation the Newton-Raphson method.
6. Write down a program to find the root of the transcendental equation by iterative method to correct up to 4 decimal places.
7. Implement Simpson's rule to approximate the definite integral of the function. Choose an appropriate number of sub-intervals and calculate the approximate value of the Integral using open-source software.
8. Use the Trapezoidal rule to estimate the Integration for a given function using open-source software.
9. Use Binomial Distribution in decision-making related to Quality control and process improvement in the manufacturing process.
10. Use Poisson distribution to calculate the number of website visitors per hour.

b. Micro Projects:

1. Prepare charts displaying various standard integration formulas.
2. Explore the use of Integral calculus to calculate the velocity and acceleration of a particle.
3. Prepare charts showing the area and volume of various geometrical shapes using Integral calculus.
4. Prepare a model showing the applications of differential equations for the rate of decay of radioactive materials.
5. Prepare a model showing the applications of differential equations for Newton's law of cooling.
6. Prepare a simulated environment to study the motion of a particle under the influence of gravity.
7. Prepare a comparative chart showing the convergence of various iterative techniques.
8. Prepare a chart consisting of 8-10 nonlinear equations made of real-world problems.
9. Download 5-7 videos based on applications of numerical integration in mechanical, civil, and auto engineering branches, watch them, and write a report to detail the mathematical steps involved.
10. Make a short video of duration 5-7 minutes for the applications of numerical integration in Chemical, Agriculture, and Ceramic engineering branches.
11. Download 5-7 videos based on engineering applications of Binomial and Poisson's distribution, watch them, and write a report to detail the mathematical steps involved.
12. Make a short video of duration 10-15 minutes on at least 7-8 engineering applications of Normal distribution.

c. Other Activities:

1. Seminar Topics:
    - Applications of Integral calculus in control systems, dynamics, and vibrations.
    - Applications of Integral calculus in production and cost analysis.
    - Applications of Integral calculus in algorithms and optimization.
    - Applications of Integral calculus in population dynamics and bio-mathematics.
    - Applications of Integral calculus in filtering and feature extraction.
    - Solving Differential Equations through SCILAB.
    - Applications of Differential Equations in population dynamics and epidemiology.
    - Differential Equations with discontinued input via Laplace Transform: Techniques and Applications.
    - Applications of Numerical Methods for engineers.
    - Numerical Solution of Nonlinear Equations using Root-Finding Algorithms: Techniques and Applications.
    - Numerical integration and its engineering applications.
    - Engineering applications of Binomial and Poisson's distribution.
    - Real-life examples of Normal Distribution.
    - Probability distribution and its engineering applications.

2. Visits: Visiting the following places would provide students an opportunity to see the application of various branches of mathematics in different fields. This will also help students to comprehend the career opportunities available in the field of mathematics.
    - Visit to a Science museum.
    - Visit a mathematics research institute.
    - Visit to a Data Science Center.
    - Visit the mathematics department of a college or university.
    - Visit a software company.
    - Visit to a Space Agency.
    - Visit to a Gaming Studio.
    - Participation in mathematics competitions.

3. Self-Learning Topics:
    - Participate in MOOCs on Integration Techniques and Applications.
    - Participate in MOOCs on Ordinary Differential Equations: Methods and Applications.
    - Participate in an Open courseware of MIT on the Newton-Raphson Method: rate of convergence.
    - Watching videos on numerical integration: Concepts and Applications.
    - Watching video on Probability distribution and its engineering applications.

M) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use the appropriate assessment strategy and its weightage in theory, laboratory, and Term Work for ensuring CO attainment. The response/performance of 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%	15%	-	-
CO-2	25%	25%	25%	20%	25%	-	-
CO-3	10%	10%	10%	20%	10%	-	-
CO-4	20%	20%	20%	20%	20%	-	-
CO-5	30%	30%	30%	20%	30%	-	-
Total Marks	**30**	**70**	**20**	**20**	**10**	**-**	**-**
			50				

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentages given are approximate
- In the 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 the achievement of each CO.

N) **Suggested Specification Table for End Semester Theory Assessment:** The specification table represents the reflection of sample representation of assessment of the 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 Integral Calculus and its Applications	10	CO1	11	4	4	3
Unit-2.0 Differential Equation	12	CO2	16	4	6	6
Unit-3.0 Numerical Solution of Nonlinear Equations	8	CO3	10	3	4	3
Unit-4.0 Numerical integration	8	CO4	12	4	6	2
Unit-5.0 Probability distribution	10	CO5	21	5	8	8
Total	**48**	**-**	**70**	**20**	**28**	**22**

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

O) Suggested Assessment Table for Laboratory (Practical): (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 Lectures, Tutorial, Case Methods, Group Discussions, Industrial visits, Industrial Training, Field Trips, Portfolio, Learning, Role Play, Live Demonstrations in Classrooms, Labs, 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.	High-end computers	Processor Intel Core i7 with Compilers and Programming Languages; RAM 32 GB, DDR3/DDR4, HDD 500 GB, OS Windows 10.	All
2.	Software	Scientific Calculators, Graphing Calculator, SCILAB, GraphEq^2.13, Microsoft Mathematics, GeoGebra, Math3D	1,2,3,4,5
3.	Printer	High-Speed Duplex Printer	
4.	Scanner	Handheld 3D scanner, Accuracy up to 0.1 mm, Resolution up to 0.2 mm, Wireless technology with an inbuilt touch screen and battery, Extended field of view for capturing both large and small objects.	

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Elementary Engineering Mathematics	B. S. Grewal	Khanna Publishers,15th Edition. ISBN: 978-81-7409-257-1
2.	Engineering Mathematics (Third edition)	Croft, Anthony	Pearson Education, New Delhi, 2014. ISBN 978-81-317-2605-1
3.	Calculus and Its Applications	Marvin L. Bittinger David J. Ellenbogen Scott A. Surgent	Addison-Wesley 10th Edition ISBN-13: 978-0-321-69433-1
4.	Calculus and Analytic Geometry	G. B. Thomas, R. L. Finney	Addison Wesley, 9th Edition, 1995. ISBN 978-8174906168
5.	Understanding Engineering Mathematics	John Bird	Routledge; First Edition ISBN 978-0415662840
6.	Advanced Engineering Mathematics	Krezig, Ervin	Wiley Publ., New Delhi,2014, ISBN: 978-0-470-45836-5
7.	Studies in the History of Indian Mathematics	C. S. Seshadri	Hindustan Book Agency (India) P 19 Green Park Extension New Delhi. ISBN 978-93-80250-06-9
8.	Mathematics-I	Deepak Singh	Khanna Book Publishing Co. (P) Ltd. ISBN: 978-93-91505-42-4
9.	Mathematics-II	Garima Singh	Khanna Book Publishing Co. (P) Ltd. ISBN: 978-93-91505-52-3
10.	Consider Dimension and Replace Pi	M.P. Trivedi and P.Y. Trivedi	Notion Press; 1st edition (2018), ISBN: 978-1644291795

(b) Online Educational Resources:

1. https://ocw.mit.edu/
2. https://tutorial.math.lamar.edu/
3. https://www.khanacademy.org/
4. https://www.feynmanlectures.caltech.edu/
5. https://www.wolframalpha.com/
6. https://www.dplot.com/
7. https://www.geogebra.org/
8. https://www.easycalculation.com/
9. https://www.scilab.org/
10. https://www.desmos.com/
11. https://nptel.ac.in/
12. https://swayam.gov.in/
13. https://ndl.iitkgp.ac.in/
14. https://parakh.aicte-india.org/
15. https://ekumbh.aicte-india.org/
16. https://learnengg.com/LE/Index
17. https://ncert.nic.in/textbook.php
18. https://nios.ac.in/online-course-material/sr-secondary-courses/mathematics-(311).aspx

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

(c) Others:

1. Online Mathematics Courses.
2. Mathematics Communities and Forums.
3. Mathematics Journals.
4. Mathematics Podcast.
5. Mathematics Tutorials.
6. Mathematics Quizzes.
7. Mathematics Animation.
8. Mathematics Simulations.
9. Mathematics Games.
10. Mathematics Puzzles.
11. Mathematics Brain Teasers.
12. Mathematics Apps.
13. Mathematics Blog.
14. Mathematics Challenges.

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A) Course Code : **2415105(P2415105/S2415105)**

B) Course Title : Engineering Drawing & Graphics
(CE, EE, ELX, ELX (R), MIE, FTS, AE, CHE, TE, CRE)

C) Pre- requisite Course(s) : Knowledge of standard geometries

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. Still to develop ability of visualization, understanding of drawing standards and free hand sketching on one side and to take advantage of digital drafting tools on other, this course addresses both the aspects. The course covers the knowledge & application of drawing instruments, familiarizes the learner about Bureau of Indian standards related to engineering drawing, developing the ability to draw and read various engineering curves, projections and dimensioning styles and finally make him able to use computer aided drafting software for developing engineering drawings related to different fields.

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 drawing instruments, drawing codes, dimensioning, conventions and symbols as per IS SP-46(2003) in engineering drawing.
- **CO-2** Draw geometrical figures, curves and engineering scales.
- **CO-3** Draw the views of objects using principles of orthographic projection.
- **CO-4** Draw isometric views of components directly or from orthographic projections.
- **CO-5** Draw free hand sketches of engineering elements, their orthographic and isometric views.
- **CO-6** Use computer aided drafting software to draw 2D and isometric geometric entities.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2415105	Engineering Drawing & Graphics	-	-	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:

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)	
2415105	Engineering Drawing & Graphics	-	-	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 Drawing Instruments to prepare 2D drawings manually. *TSO 1b.* Use different lines and annotations for a given situation. *TSO 1c.* Draw engineering scale for the given situation. *TSO 1d.* Choose appropriate scale factor for the drawing as per given situation. *TSO 1e.* Dimension the given geometric figure using IS SP-46 standard. *TSO 1f.* Draw the given regular geometric figure with tangents and normal. *TSO 1g.* Draw selected engineering curve.	**Unit-1.0 Basic Elements of Drawing** 1.1 Methods to use different Drawing Instruments and supporting materials. 1.2 Different lines and conventions in engineering drawing. 1.3 Engineering scales and applications: Reduced, enlarged & full size (only Plain scale) 1.4 Dimensioning techniques: types and applications of chain, parallel and coordinate dimensioning as per SP-46. 1.5 Regular Geometrical figures, Tangency constructions. 1.6 Engineering Curves: only Ellipse and Parabola using concentric circle method, rectangular method and Eccentricity method when focus and directrix are given.	**CO1, CO2**
TSO 2a. Explain the different types of projections & their uses. *TSO 2b.* Draw the orthographic projections of different objects *TSO 2c.* Convert pictorial views into orthographic views	**Unit-2.0 Orthographic Projections** 2.1 Concept and applications of Orthographic, Perspective, Isometric and Oblique Projections. 2.2 Orthographic Projection: First and Third angle 2.3 Draw orthographic views of simple 3D entities containing lines, circles and arcs with axis/orientation parallel and/or perpendicular to the projection planes only. Problems should be restricted up to three views Front view/Elevation, Top view/Plan and Side views only using First Angle Method only. 2.4 Conversion of simple pictorial views into orthographic views. (Domain specific illustrative problems to be given by the teacher)	**CO1, CO2, CO3**
TSO 3a. Explain the Isometric Projection, Isometric view and Isometric Scale. *TSO 3b.* Draw isometric dimensioning on the given isometric view. *TSO 3c.* Explain the Methods of constructing isometric drawing *TSO 3d.* Draw Isometric View of the given object containing elements like rectangular,	**Unit-3.0 Isometric Projection** 3.1 Introduction to isometric projection. 3.2 Isometric scale and Natural Scale. 3.3 Isometric view and isometric projection. 3.4 Illustrative problems limited to Isometric projection of objects containing rectangular,	**CO1, CO3, CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
circular, cylindrical shapes and slots on sloping and plane surfaces. *TSO 3e.* Convert the given orthographic views into isometric View/Projection.	circular, cylindrical shapes and slots on sloping and plane surfaces. 3.5 Conversion of orthographic views into isometric View/projection.	
TSO 4a. Sketch the given straight line, square, rectangle, circle and arc. *TSO 4b.* Sketch the given simple orthographic and isometric views of the given part. *TSO 4c.* Sketch the given domain specific engineering element/component.	**Unit-4.0 Free Hand Sketches of Engineering Elements** 4.1 Materials for Sketching. 4.2 General Guidelines for Freehand Sketching. 4.3 Freehand sketching of straight lines, square, rectangle, circles and arcs. 4.4 Free hand sketches of orthographic views. 4.5 Free hand sketches of isometric views. 4.6 Freehand sketching of domain specific engineering elements/components (e.g. Bolt, Nut, Washer, Stud, Screw, simple machine parts, etc. in case of mechanical, production, automobile, electrical engineering).	**CO5**
TSO 5a. Use computer aided drafting software for creating the institute Drawing Template. *TSO 5b.* Use computer aided drafting software for creating the given simple 2D entity.	**Unit-5.0 Basic Computer aided Drafting** 5.1 Basics of AutoCAD or any other drafting software–interface, screen layout, starting commands from menus, command line. 5.2 Coordinate system, Angular measurements, Point specification. 5.3 Drawing aids - Grid, Snap, Ortho, Osnap, Units, Limits, Layers, Linetype. 5.4 Opening and Saving drawing files. 5.5 Creating User Defined Templates. 5.6 Methods of Selecting and deleting Objects. 5.7 Undo and Redo. 5.8 Creating basic drawings objects - lines, arc, circles, ellipses, polyline and polygons.	**CO1, CO2, CO6**
TSO 6a. Use computer aided drafting software for creating orthographic views of the given object. *TSO 6b.* Use computer aided drafting software for creating isometric views of the given object. *TSO 6c.* Print the given drawing (using institute template) on A4/A3 sheet.	**Unit-6.0 Advanced Computer aided Drafting** 6.1 Modify commands - erase, copy, move, rotate, scale, stretch, 6.2 Array: concept and applications. 6.3 Controlling Drawing display 6.4 Text and Dimensioning 6.5 Layers: concept and application 6.6 Drawing orthographic vies using drafting software with principles mentioned in Unit 2. 6.7 Drawing isometric views using drafting software with principles mentioned in Unit 3. 6.8 Printing and plotting of drawings.	**CO1, CO2, CO3, CO4, CO6**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2415105

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use manual drawing instruments *LSO 1.2.* Draw simple 2D entities using manually drawing instruments.	1.	Geometric Construction: • Draw set of lines with different conditions (two problems). • Draw circle and arcs with different geometric conditions and constraints (two problems). • Draw polygons by general methods (Triangle, square, pentagon, hexagon, heptagon) (Three problems).	CO1, CO2
LSO 2.1. Draw conic sections using manually drawing instruments. *LSO 2.2.* Use different methods of construction of ellipse and parabola.	2.	• Construct ellipse using four center method, arc of circle method and rectangle method. • Construct parabola using rectangular method, and parallelogram method.	CO2
LSO 3.1. Apply concepts of orthographic projection in drawing the given simple object on drawing sheet. *LSO 3.2.* Visualize the three views related to the given object based on its shape and orientation.	3.	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. (three views of each object, total six problems)	CO3
LSO 4.1. Apply concepts of orthographic projection to draw three views of given domain specific object/ component.	4.	Draw Orthographic projections of domain specific objects (three views of each object) (Two problems).	CO3
LSO 5.1. Use concepts of Isometric projection to draw the given simple object with slant surface.	5.	Draw Isometric view of simple objects having plain and slanting surface by using natural scale. (Three problems)	CO4
LSO 6.1. Visualize the 3D shape of the given object. *LSO 6.2.* Convert the given 2D figures/views into 3Dobject.	6.	Convert the orthographic views of an object to isometric view. (Two problems)	CO3, CO4
LSO 7.1. Draw free hand sketches of the given domain specific object/component	7.	Draw free hand sketches/conventional representation of your domain specific components (Six problems)	CO5
LSO 8.1. Draw 3D free hand sketches from the given isometric shape.	8.	Draw free hand sketch of isometric drawings (prepared in Sr. No. 05) without using any instruments.	CO5
LSO 9.1. Draw 3D free hand sketches of the given real object/component.	9.	Given the 3D model of an object, student will try to imagine the three views and draw them with free hand in the sketch book.	CO5
LSO 10.1. Use computer aided drafting software to create and modify a template. *LSO 10.2.* Insert any picture in the existing AutoCAD drawing	10.	Prepare a template for your institute of A-4 size with title block and institute logo.	CO6

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 10.3. Insert text in the existing AutoCAD drawing			
LSO 11.1. Use computer aided drafting software to create and modify simple 2D entities. *LSO 11.2.* Use computer aided drafting software to create and modify circles and arcs with different geometric conditions and constraints	11.	Computer Aided Drafting: Use the software to draw following simple 2-D entities using Draw commands individually • Draw circle and arcs with different geometric conditions and constraints (two problems). • Draw polygons (Triangle, square, pentagon, hexagon, heptagon) (Three problems).	CO6
LSO 12.1. Use computer aided drafting software to calculate Area, Perimeter, and Centroid of the given 2D entity	12.	Use the 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.	CO6
LSO 13.1. Use computer aided drafting software to draw complex 2D entities.	13.	Use the software to draw four domain specific complex 2-D entities assigned by the teacher using Draw, Edit and Modify commands	CO6
LSO 14.1. Use computer aided drafting software to create and modify 2D entities. *LSO 14.2.* Use computer aided drafting software to create and modify the given orthographic views.	14.	Use the software to draw orthographic views of • 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. (three views of each object, total six problems)	CO3, CO6
LSO 15.1. Use computer aided drafting software to create and modify the given isometric entities.	15.	Use the software to draw isometric views of three 3D objects containing lines, arcs, circles, holes, ribs and slots	CO4, CO6

L) Suggested Term Work and Self Learning: S2415105 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments:

1. Sketch progressive and parallel dimensioning.
2. Prepare a list of industrial and household components in which conic curves are used and justify the utility of these curves.
3. Write the equations for parabola in different quadrants and observe the effect of changing eccentricity in case of parabola.
4. Exercises on drawing orthographic views of engineering domain specific simple parts.
5. Exercise on drawing isometric views of different objects.
6. Exercises on converting the orthographic views of an object to isometric view.
7. Exercise on missing views.
8. Exercises on creating simple digital drawings, orthographic views and isometric views.
9. Each student should explain at least one problem for construction and method of drawing in sheet/computer to all batch colleagues. Teacher will assign the problem of particular sheet to be explained to each student batch.
10. Each student will assess at least one sheet 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. Through experimentation, justify that the eccentricity of an ellipse is 1.
2. Cut a Cardboard/Thermocole cone with various section planes to get circle, ellipse, parabola and hyperbola.
3. Explore the applications of engineering curves in different fields of engineering and prepare a short report.
4. List the shapes and curves you are observing around you in real life with name of place and item. (For Ex. ellipse, parabola, hyperbola, cycloid, epicycloids, hypocycloid, involute, spiral helix).
5. Cut triangular, square, rectangular and circular shaped Cardboard/Thermocole pieces and observe them by placing in different positions with respect to the protection planes.
6. Take a medium sized hexagonal nut and draw its isometric projection.
7. The teacher will assign one set of orthographic projections and ask the student to develop 3D Thermocol models of the same.
8. Prepare an A4 digital drawing template of your institute with title block and institute logo.
9. Each batch will collect 5 components/circuits/items specific to their branch and draw their orthographic views using AutoCAD software.
10. Download 5 videos on shortcuts used in AutoCAD, watch them and write a report to detail out the steps involved, Commands used.

c. Other Activities:

1. Seminar Topics:

    - Standard symbol and conventions used in engineering drawings related to your branch/domain.
    - Commercially available other Computer Aided Drafting Software.
    - Compatibility of AutoCAD drawings compared to Conventional Drawing.

2. Visits: Collect production/construction/circuit drawings from nearby industries/shop/builders and observe the type of orthographic projection, symbol of projection and various views used.

3. Self-Learning Topics:

    - Types of lines and dimensioning in engineering drawing.
    - Different methods of drawing Arcs and Circles in AutoCAD software.

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%	-	-	05%	16%
CO-2	-	-	05%	20%	20%	05%	16%
CO-3	-	-	20%	20%	20%	15%	16%
CO-4	-	-	20%	20%	20%	15%	16%
CO-5	-	-	15%	20%	20%	20%	16%
CO-6	-	-	35%	20%	20%	40%	17%
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.	Geometric Construction: • Draw set of lines with different conditions (two problems). • Draw circle and arcs with different geometric conditions and constraints (two problems). • Draw polygons by general methods (Triangle, square, pentagon, hexagon, heptagon) (Three problems).	CO1, CO2	30	60	10
2.	• Construct ellipse using four center method, arc of circle method and rectangle method • Construct parabola using rectangular method, and parallelogram method	CO2	30	60	10
3.	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 third quadrant with its axis parallel to H.P. and V.P • Different objects having cylindrical surfaces, ribs. (three views of each object, total six problems)	CO3	30	60	10
4.	Draw Orthographic projections of domain specific objects (three views of each object) (Two problems).	CO3	30	60	10
5.	Draw Isometric view of simple objects having plain and slanting surface by using natural scale. (Three problems)	CO4	30	60	10
6.	Convert the orthographic views of an object to isometric view (Two problems)	CO3, CO4	30	60	10
7.	Draw free hand sketches/conventional representation of your domain specific components (Six problems)	CO5	30	60	10
8.	Draw free hand sketch of all above isometric drawings (prepared in Sr. No. 06) without using any instruments.	CO5	30	60	10
9.	Given the 3D model of an object, student will try to imagine the three views and draw them with free hand in the sketch book.	CO5	40	50	10
10.	Prepare a template for your institute of A-4 size with title block and institute logo.	CO6	40	50	10
11.	Computer Aided Drafting: Use the software to draw following simple 2-D entities using Draw commands individually • Draw circle and arcs with different geometric conditions and constraints (two problems).	CO6	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
	• Draw polygons (Triangle, square, pentagon, hexagon, heptagon) (Three problems).				
12.	Use the 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.	CO6	40	50	10
13.	Use the software to draw four domain specific complex 2-D entities assigned by the teacher using Draw, Edit and Modify commands	CO6	40	50	10
14.	Use the software to draw orthographic views of • 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. (three views of each object, total six problems)	CO3, CO6	40	50	10
15.	Use the software to draw isometric views of three 3D objects containing lines, arcs, circles, holes, ribs and slots	CO4, CO6	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.	Drawing Table with Drawing Board	Drawing Table with Drawing Board of Full Imperial/ A1 size.	1 to 9
2.	Models and Charts	Normal and cut sectioned Models and Charts of objects for orthographic / isometric projections	1 to 9
3.	Drawing equipments and instruments	Drawing equipments and instruments for class room teaching-large size: • T-square or drafter (Drafting Machine). • Set squires (450 and 300-600) • Protector. • Drawing instrument box (containing set of compasses and dividers). • Drawing sheets, Drawing pencils, Eraser. • Drawing pins / clips	1 to 9

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
4.	Sample production/construction drawings	From nearby industries, construction companies and developed by senior teachers of the state	All
5.	Interactive board (165 x 130 cm)	Supports dual touch, dual write and intuitive gestures, such as toss, rotate and zoom with multitouch operating systems, such as Windows®	All
6.	Computer aided drafting software like AutoCAD	Latest educational licensed network version	9 to 15
7.	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	9 to 15
8.	Printer/plotter	A3 size	9 to 15

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Engineering Drawing	N.D. Bhatt	Charotar Publishing House, Anand, Gujrat 2010; ISBN: 978-93- 80358-17-8.
2.	Engineering Drawing	R.K. Dhawan	S. Chand and Company, New Delhi; ISBN: 81-219-1431-0.
3.	Engineering Drawing	P.J. Shah	S. Chand & Company, New Delhi, 2008, ISBN:81-219-2964-4.
4.	Engineering Graphics with AutoCAD	A.K. Sarkar, A.P. Rastogi, D.M. Kulkarni	PHI Learning Private Limited-New Delhi (2010); ISBN: 978-8120337831.
5.	Engineering Drawing and Graphics using AutoCAD	T. Jeyapoovan	Vikas Publishing House Pvt. Ltd, Noida, 2011; ISBN: 978-8125953005.
6.	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

(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

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

******

A) Course Code : 2425106(P2425106/S2425106)

B) Course Title : Mechanical Workshop (CE, AE, ME, ME (Auto), MIE, CRE, CHE)

C) Pre- requisite Course(s) :

D) Rationale:

Mechanical Workshop is a basic practical engineering course. Knowledge of basic workshops such as wood working shops, fitting & machine shop, sheet metal shop, welding shop, black smithy and is essential for students to perform duties in industries and field agencies. This course will help the students to develop practical skills by performing various practical tasks using various hand tools, equipment and machinery in the respective shops, which will be useful in many fields like workshop, home and agriculture, construction etc. Job making in the workshop develops an attitude of teamwork and safety awareness. This course provides industrial environment in educational institutions.

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** Undertake wood working operations economically and safely.
- **CO-2** Carryout fitting and turning operations properly in a given situation.
- **CO-3** Perform various joining operations using welding, brazing, and soldering methods.
- **CO-4** Perform various sheet metal operations as per given sketch/ drawing.
- **CO-5** Undertake black smithy operations safely.

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** Lifelong Learning	**PSO-1**	**PSO-2**
CO-1	3	2	2	3	1	-	2		
CO-2	3	2	2	3	2	-	2		
CO-3	3	2	2	3	1	-	1		
CO-4	3	1	1	3	1	1	1		
CO-5	3	3	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:

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				
2425106	Mechanical Workshop	-	-	04	02	06	03

Legend:

CI: Classroom instruction (Includesdifferentinstructional/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, fieldorotherlocationsusingdifferentinstructional/Implementationsstrategies)

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

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

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

C: Credits= (1xCIhours) + (0.5xLIhours) + (0.5xNotionalhours)

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work& Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2425106	Mechanical Workshop	-	-	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(includesprocessandproductassessmentusingratingScalesandrubrics)

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 Unit: (Not Applicable)

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2425106

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Use relevant wood working tools and instruments as per given job. *LSO 1.2* Undertake wood working operations like marking, cutting, plaining and finishing etc. *LSO 1.3* Prepare given wooden joints as per given sketch / drawing.	1.	1.1 Prepare one simple job of wood working comprises of marking, cutting, plaining and finishing as per given drawing/sketch. 1.2 Prepare any two wooden joints safely as per given drawing using suitable tools- - Mortise joint - Dovetail joint - Half lap joint. - Cross joint - Tenon Joint - Bridle joint	CO-1
LSO 2.1 Prepare list of relevant tools, equipment, machines and measuring instruments used in fitting shop as per given situation. *LSO 2.2* Perform marking, cutting, filing, punching, drilling, and finishing operations as per given fitting job safely. *LSO 2.3* Select relevant single point cutting tool and associated parameters for a given turning job. *LSO 2.4* Undertake turning operations economically and safely in a given situation	2.	2.1 Selection of different fitting tools, equipment, machines and measuring instruments in a given situation. 2.2 Prepare one simple fitting job (square of 50 mm side /square of 40 mm side with 5mm drill at Centre) comprises of marking, filing, punching, drilling, and finishing as per given drawing/sketch. 2.3 Prepare given step turning / taper turning job as per given sketch/ drawing.	CO-2
LSO 3.1 Select suitable joining process in a given situation. *LSO 3.2* Use Personal Protective Equipment in welding shop. *LSO 3.3* Perform gas welding operations in a given situation to prepare joint safely. *LSO 3.4* Prepare given welding joint safely using arc welding in a given situation. *LSO 3.5* Carryout soldering / brazing operation(s) as per given job.	3.	3.1 Prepare simple job of joining by using suitable joining process as per given sketch. 3.2 Prepare a Butt joint / lap joint using gas welding as per given sketch / drawing safely. 3.3 Prepare a Butt joint / lap joint by arc welding using suitable welding parameters as per given sketch / drawing economically and safely. 3.4 Prepare simple job using soldering/ brazing operations as per given drawing.	CO-3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 4.1 Select suitable sheet metal tools, machinery / equipment for given used as per requirements. *LSO 4.2* Select suitable sheet metal operations in a given situation. *LSO 4.3* Perform relevant sheet metal operations such as shearing, bending, drawing, squeezing, snipping, riveting, grooving etc.to prepare utility jobs safely as given sketch/ drawing.	4.	4.1 Prepare one sheet metal job using cutting, bending, edging and joining operations as per given drawing. 4.2 Prepare a sheet metal rectangular tray of dimension of 300X100X50 mm. 4.3 Prepare any one utility job of sheet metal using suitable sheet metal tools and operations.	CO-4
*LSO 5.1*Select suitable black smithy tools and operations to complete jobs as per requirements. *LSO 5.2* Perform various operations safely to prepare given black smithy job(s). *LSO 5.3*Follow safety procedures and use personal safety equipment during black smithy.	5.	5.1 Selection of various black smithy tools, equipment, machines and measuring instruments used as per given situations. 5.2 Prepare S shaped hook from given MS rod of length 220mm and diameter 6 mm in black smithy shop. 5.3 Prepare a garden trowel, sickle, and shovel as per the instruction provided by the instructor	CO-5

L) Suggested Term Work and Self Learning: S2425106 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. Visit different classrooms and prepare a list of wooden joints used in sitting furniture.
2. List the various lathe operations and their applications used in machine repairing shop.
3. Visit nearby welding shop and prepare a list of welding consumables used for various types of welding.
4. Observe small agricultural equipment used nearby you and repair it.
5. Prepare a list of different types of sheets with specification available in market.

c. Other Activities:

1. Seminar Topics:

- Safety practices and use of personal safety equipment in workshops.
- Different types of machines tools and their functions used in workshops.
- Operating precautions and safety norms for various types of machine and tools in workshops

2. Visits:

- Visit any nearby machine shop / carpentry shop / fitting shops /welding shops and sheet metal workshop and prepare a report.
- Make a detailed market survey of local dealers for procurement of workshop tools, equipment machinery and raw materials.

3. Self-learning topic:

- Causes and remedies of welding defects.
- Prepare a brief proposal for making of various small agricultural equipment/machinery.
- Repairing of defective tools and machines in workshop.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	-	-	20%	20%	20%	20%	20%
CO-2	-	-	20%	20%	20%	20%	20%
CO-3	-	-	20%	20%	10%	20%	20%
CO-4	-	-	20%	20%	25%	20%	20%
CO-5	-	-	20%	20%	25%	20%	20%
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 is approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: (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.	Prepare one simple job of wood working comprises of marking, cutting, plaining and finishing as per given drawing/sketch.	CO-1	50	40	10
2.	Prepare any two wooden joints safely as per given drawing using suitable tools- • Mortise joint • Dovetail joint • Half lap joint. • Cross joint • Tenon Joint • Bridle joint	CO-1	40	50	10
3.	Selection of different fitting tools, equipment, machines and measuring instruments in given situation.	CO-2	60	30	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
4.	Prepare one simple fitting job (square of 50 mm side /square of 40 mm side with 5mm drill at center) comprises of marking, filing, punching, drilling and finishing as per given drawing/sketch.	CO-2	50	40	10
5.	Prepare given step turning / taper turning job as per given sketch/ drawing.	CO-2	30	60	10
6.	Prepare simple job of joining by using suitable joining process as per given sketch.	CO-3	60	30	10
7.	Prepare a Butt joint / lap joint using gas welding as per given sketch / drawing safely.	CO-3	40	50	10
8.	Prepare a Butt joint / lap joint by arc welding using suitable welding parameters as per given sketch / drawing economically and safely.	CO-3	40	50	10
9.	Prepare simple job using soldering/ brazing operations as per given drawing.	CO-3	30	60	10
10.	Prepare one sheet metal job using cutting, bending, edging and joining operations as per given drawing.	CO-4	50	40	10
11.	Prepare a sheet metal rectangular tray of dimension of 300X100X50 mm.	CO-4	30	60	10
12.	Prepare any one utility job of sheet metal using suitable sheet metal tools and operations.	CO-4	30	60	10
13.	Selection of various black smithy tools, equipment, machines and measuring instruments used as per given situations.	CO-5	60	30	10
14.	Prepare S shaped hook from given MS rod of length 220mm and diameter 6 mm in black smithy shop.	CO-5	30	60	10
15.	Prepare a garden trowel, sickle, and shovel as per the instruction provided by the instructor.	CO-5	30	60	10

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

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical 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.	Lathe machine	Capacity Light Duty Heavy Duty Height of center 165 mm 254 mm Swing Over Bed 325 mm 490 mm Swing Over Cross Slide 175 mm 290 mm Movement of Cross Slide 225 mm 300 mm	All

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		Swing in gap 500mm 800 mm With suitable motor drive with all accessories.	
2.	Drilling machine	Up to 15 mm drill cap with 1 HP motor 1000mm height	1,2
3.	Wood working tools	Marking and measuring tools, saw, claw hammer, mallet, chisels, planers, squares	1,2
4.	vice	Carpentry vice 200 mm, bench vice 100mm, pipe vice 100 mm	1,2,3,4,5,6,7,8,9,10,11
5.	Work benches	Size 2000x1000x750 mm	1,2,3,4,5,6,7,8
6.	Fitting tools	Ball pen Hammers(500g), cross pean hammer, chisels, files, hacksaw, surface plate, punch, v block, angle plate, try square, marking block, steel rule, twist drills, reamers, tap set, die set of suitable sizes	3,4,5
7.	Surface plate	600x900 mm grade I	All
8	Welding machine	20 KV, 400 A Welding current, welding cable 400 amp, with all accessories	6,7,8
9	Soldering and brazing equipment	Solder. Soldering iron (35 W) soldering wick, magnifying glass, wire cutters, brazing torch, aluminum brazing rod,	9
10	Gas welding and hand tools	Welding torch, welding tip, pressure regulator, oxygen and acetylene gas cylinder and cutting kit with cylinder and regulator, spark lighter	7,8
11	Arc welding and hand tools	Electrode holder, cable connector, chipping hammer, earthing clamp, wire brush.	6,7,8
12	Sheet bending and cutting machine	Mild steel automatic metal sheet bending machine (size 0.5 mm-20 mm X 1000 mm -6300 mm), compound saw (blade diameter 305 mm, power consumption 1520 W, 4000 RPM)	10,11,12
13	Sheet metal and hand tools	Snip, shears sheet gauge, straight edge, L/T square scriber, divider trammel, punches, pliers, stakes, groovers, limit set	10,11,12
14	Black smithy tools and equipment	Anvil (WEIGHT-167 lbs, horn-73/4", face length-10", rear-71/2"), hammer (double face sledge hammer10 kg), scaling hammer, chipping hammer, tongs (500g ,flat nose size 15 inch) open hearth ,air blower (60 hp capacity 40000 m3/hr.), swage block (14X14X5 inch material iron)	13,14,15
15	Fire extinguisher	A, B, C type with capacity of 5 kg and 10 kg of CO_2 type	All

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Workshop practice	R. K. Rajput	Laxmi Publications, New Delhi ISBN: 978-9380856650
2.	Workshop practice	Bawa,H.S	McGraw Hill Education, Noida ISBN:978-0070671195
3.	Engineering Workshop Practice	A.K. Sarathe	Khanna Book Publishing Co.(P) LTD. New Delhi ISBN:978-93-91505-51-6

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
3.	A textbook of workshop Technology.	R.S. Khurmi and J.K. GUPTA	S. Chand and Co. New Delhi ISBN:9788121908689
4.	Manufacturing Technology Volume-01	P.N. Rao	McGraw Hill Education, Noida ISBN-9789353160500

(b) Online Educational Resources:

1. **Wooden joints**: https://www.youtube.com/watch?v=-f7tTNRH_04
2. **Carpentry tools**: https://www.youtube.com/watch?v=ZyN9Tw9VTSo
3. **Fitting tools**: https://www.youtube.com/watch?v=jbRgJbIGAwc
4. **V -fitting**: https://www.youtube.com/watch?v=iDJ_sMvXsYs
5. **Square -fitting**: https://www.youtube.com/watch?v=NHLpRgLGeEo
6. **Lathe and its parts**: https://www.youtube.com/watch?v=LtMJonWHKyU
7. **Lathe operation**: https://www.youtube.com/watch?v=hheFVuUBpxo&t=235s
8. **Classification of welding joints**: https://www.youtube.com/watch?v=cQEUJnMYf_U
9. **Gas welding**: https://www.youtube.com/watch?v=-SA4D098u-Q
10. **Arc welding**: https://youtu.be/5hRgwnejWPs
11. **Soldering and brazing**: https://www.youtube.com/watch?v=fnEFuzeM8cc
12. **Sheet metal working**: https://www.youtube.com/watch?v=KFdoAYvU4SI
13. **Sheet metal working**: https://www.youtube.com/watch?v=k8VskWhx0AY
14. **Sheet metal work**: https://www.youtube.com/watch?v=fNB1sunQ66g
15. **Black smithy tools**: https://www.youtube.com/watch?v=O3xyNWHxQN8
16. **Black smithy operation**: https://www.youtube.com/watch?v=uYvgBwP-1nY

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. Kents Mechanical Engineering Handbook, John Wiley and Sons, New York.
2. Workshop practice Handbook.
3. Lab Manuals.

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A) Course Code : **2400006(T2400006/P2400006/S2400006)**

B) Course Title : **Environmental Education and Sustainable Development**
(Common for all Programmes)

C) Pre- requisite Course(s) :

D) Rationale :

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

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

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

- **CO-1** Explain the importance of ecosystem for the protection of environment
- **CO-2** Use relevant air & water pollution control methods to solve pollution related issues
- **CO-3** Recognize relevant energy sources required for domestic & industrial application
- **CO-4** Analyze the issues of climate change and its impact on sustainability
- **CO-5** Apply engineering solutions/methods/legislations to reduce the activities that are harming the environment.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ 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	-	2		
CO-2	3	2	2	2	2	-	2		
CO-3	3	-	-	-	3	-	2		
CO-4	3	3	-	2	2	-	2		
CO-5	3	-	3	3	2	2	2		

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400006	Environmental Education and Sustainable Development	01	-	01	01	03	02

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment(TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400006	Environmental Education and Sustainable Development	15	-	10	-	10	15	50

Legend:

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

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

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

Note:

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

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

J) Theory Session Outcomes (TSOs) and Units: T2400006

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

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	3.4.2 Wind energy in India- Advantages and challenges of harnessing wind energy 3.4.3 Environmental benefits & limitations 3.5 Biomass 3.5.1 Types of Biomass energy sources 3.5.2 Energy content in Biomass of different types 3.5.3 Biogas production 3.6 Concept and advantages of hydroponics or aquaponics system to demonstrate soil less cultivation and integration of fish and plant cultivation. 3.7 Water conservation and sustainable development 3.8 New Energy Sources: Hydrogen energy, Ocean energy & Tidal energy	
TSO 4a. Describe impact of climate change on human life *TSO 4b.* Identify the factors contributing to climate change *TSO 4c.* Explain sustainable development goals to transform the world *TSO 4d.* Develop implementation strategies for action plan on climate change	**Unit-4.0 Climate Change and Sustainable Development** 4.1 Impact of Climate change 4.2 Factor contributing to climate change 4.3 Sustainable development Goals (SDGs) 4.4 Action Plan on Climate Change- India	**CO4**
TSO 5a. Identify the elements of a successful management system *TSO 5b.* Explain green building concept & its benefits *TSO 5c.* Apply 5R concept in a given building construction project *TSO 5d.* Explain various environment protection laws *TSO 5e.* Explain carbon foot-print & carbon credit	**Unit-5.0 Environmental legislation and Sustainable Building Practices** 5.1 Environment management system and Planning 5.2 Green Building concept 5.3 Green and sustainable building materials - 5R concept 5.4 Environment protection acts, legislation and Laws 5.5 Zero carbon foot-print building for sustainable constriction.	**CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400006

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use of Air pollutant analyzer to determine the air pollution level *LSO 1.2.* Collect air samples for pollution level detection	1.	Determination of air pollutants harming local environment	CO2
LSO 2.1 Use of Water pollutant analyzer to determine the water pollution LSO 2.2 Collect water samples for pollution level detection	2	Determine the water pollutants harming local environment	CO2
LSO 3.1 Prepare report on EIA of a given context and area. LSO 3.2 Collection of stakeholders view on effect on environment about a particular project/activity.	3.	Carry out the Environmental Impact Assessment (EIA) for a given project /activity of development	CO1 CO3
LSO 4.1 Predict of possible factors causing effects of climate change LSO 4.2 Effect of Ice melting on sea water	4.	Assessment of the impact of climate change on local environment	CO1 CO4
LSO 5.1 Elaborate the uses of sustainable building materials, the considering 3R LSO 5.2 Trace of Carbon foot print due to construction of a small building	5.	Demonstration of sustainable building materials in lab/workshop	CO2 CO5
LSO 6.1 Set up sample recycling bins in the laboratory LSO 6.2 Appreciate the importance of recycling and environmental benefits LSO 6.3 Explain the importance of 3 R	6.	Demonstration of the recycling process for the different materials such as paper, plastic etc. for waste management	CO3
LSO 7.1 Explain the process of composting LSO 7.2 disseminate the use of composting process to near and dear for soil health and fertility for generating organic food	7	Setting up composting bins in the laboratory to demonstrate the process of composting organic waste	CO3
LSO 8.1 Calculate own water footprint for daily activities LSO 8.2 Explain the importance of reducing water consumption and conserve water resources.	8	Calculation of personal water footprint for daily water usage for activities like bathing, cooking and laundry.	CO3
LSO 9.1 Explore the alternative / renewable sources of energy in day to day life	9.	Develop bio mass energy in the laboratory	CO3 CO4
LSO 10.1 Explore the alternative / renewable sources of energy in day to day life	10.	Develop solar model in the laboratory	CO3
LSO 11.1 Explore the alternative / renewable sources of energy in day to day life	11.	Develop wind turbine model in the laboratory	CO4

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

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

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

b. Micro Projects:

- Conduct of EIA of a project/activity such as construction of roads in the local area. Prepare a report on:

  (a) Environmental issues in your city
  (b) SDGs and environment related acts/laws applicable in your state and in India.
  (c) Current-status & future-prospects of Wind Energy
  (d) New energy sources

- Prepare a model of rain water harvesting system to demonstrate how rainwater can be collected and stored for various purposes such as irrigation and toilet flushing.

- Students may be asked in group to set up a small solar panel to compare the energy output under different lighting condition and angles to understand the concept of solar energy and its potential applications.

c. Other Activities:

1. Seminar Topics:
   - Climate change issue and problems
   - Sustainable development- Global practices
   - Factor affecting sustainability in India

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

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

3. Self-Learning Topics:

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

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	-	15%	-	-	20%	20%
CO-2	10%	-	10%	25%	-	10%	20%
CO-3	15%	-	15%	25%	50%	15%	20%
CO-4	30%	-	30%	50%	50%	15%	20%
CO-5	30%	-	30%	-	-	40%	20%
Total Marks	**15**	**-**	04	04	02	**10**	**15**
			10				

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Determine the Air and water pollutants harming local environment	CO1	30	60	10
2.	Determine the water pollutants harming local environment	CO1	40	50	10
3.	Carry out the Assessment of Environmental Impact (EIA) for a given project /activity of development	CO1 CO3	30	60	10
4.	Assess the impact of climate change on local environment	CO1 CO4	30	60	10
5.	Demonstrate sustainable building materials in lab/workshop	CO2 CO5	30	60	10
6.	Demonstrate the recycling process for the different materials such as paper, plastic etc. for waste management	CO3	50	40	10
7.	Setting up composting bins in the laboratory to demonstrate the process of composting organic waste	CO3	50	40	10
8.	Calculation of personal water footprint for daily water usage for activities like bathing, cooking and laundry.	CO3	50	40	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
9.	Develop bio mass energy in the laboratory	CO3 CO4	30	60	10
10.	Develop solar model in the laboratory	CO3	30	60	10
11.	Develop Wind turbine model in the laboratory	CO4	40	50	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

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

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

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

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Air analyzer	Air Quality Meter Product Type: Measuring Instrument Analysis Time: 2 sec to 8-hour 59 min. 59 sec Automation Grade: Automatic	1
2.	Water Analyzer	Multi-Parameter Water Testing Meter Digital LCD Multi-Function Water Quality Monitor PH/EC/TDS/Salt/S. G/CF/ORP	2
3.	Sustainable Building Materials	As per availability in the market	2,5
4.	Solar energy Panel – KT	Solar Panel Kit 5 LEDs, 2 ON/Off Switch, Wire, 2 Crocodile Clip	7
5.	Bio mass/energy installation -kit	The Bio-energy Science Kit is a great way to find out how a direct ethanol fuel cell works.	6
6.	Wind power energy -Kit	4M wind turbine kit, to demonstrate power of wind and convert it into electricity by building your own turbine.	8
7.	Ice melting demo kit	Simple bowls of different sizes	--

R) Suggested Learning Resources:

(a) Books:

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

(b) Online Educational Resources:

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

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

(c) Others:

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

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