Curriculum of Diploma Programme

in

Renewable Energy

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

State Board of Technical Education
(SBTE), Bihar

Semester – III
Teaching & Learning Scheme

Course Codes	Category of course	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				
2470301	**PCC**	**Introduction to Renewable Energy**	03	-	04	02	09	06
2425302	**PCC**	**Material Science & Engineering**	02	01	-	02	05	04
2425303	**PCC**	**Strength of Materials for Mechanical Engg.** (ME, Me (Auto))	03	-	04	02	09	06
2425304	**PCC**	**Basic Thermodynamics** (ME, ME (Auto))	02	01	04	02	09	06
2470305	**PCC**	**Solar Energy System**	-	-	04	02	06	03
2425306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	02	02	04	02
2400207	**NRC**	**Indian Constitution** (Common for All Programmes)	01	-	-	-	01	01
2400108	**NRC**	**Essence of Indian Knowledge System and Tradition** (Common for All Programmes)	01	-	-	-	01	01
2400110	**NRC**	**Community/ Society Development** (AIML, AE, CSE, ELX (R), CHE, EE, ME, ME (Auto), MIE, FTS, CACDDM, FPP)	01	-	-	-	01	01
Total			**13**	**2**	**18**	**12**	**45**	**30**

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

Legend:

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

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

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

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

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

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

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

Semester - III
Assessment Scheme

Course Codes	Category of course	Course Titles	Assessment Scheme (Marks)						
			Theory Assessment (TA)		Term work &Self Learning Assessment (TWA)		Lab Assessment (LA)		Total Marks (TA+TWA+LA)
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2470301	**PCC**	**Introduction to Renewable Energy**	30	70	20	30	20	30	200
2425302	**PCC**	**Material Science & Engineering**	30	70	20	30	-	-	150
2425303	**PCC**	**Strength of Materials for Mechanical Engg.** (ME, Me (Auto))	30	70	20	30	20	30	200
2425304	**PCC**	**Basic Thermodynamics** (ME, ME (Auto))	30	70	20	30	20	30	200
2470305	**PCC**	**Solar Energy System**	-	-	20	30	20	30	100
2425306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	10	15	10	15	50
2400207	**NRC**	**Indian Constitution** (Common for All Programmes)	25	-	25	-	-	-	50
2400108	**NRC**	**Essence of Indian Knowledge System and Tradition** (Common for All Programmes)	25	-	-	-	-	-	25
2400110	**NRC**	**Community/ Society Development** (AIML, AE, CSE, ELX (R), CHE, EE, ME, ME (Auto), MIE, FTS, CACDDM, FPP)	25	-	-	-	-	-	25
Total			**195**	**280**	**135**	**165**	**90**	**135**	**1000**

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

Legend:

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

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

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

Note:

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

A) Course Code : 2470301 (T2470301 / P2470301 / S2470301)

B) Course Title : Introduction to Renewable Energy

C) Pre- requisite Course(s) : Environmental Education andSustainable Development

D) Rationale :

Introduction to Renewable Energy helps students in understanding renewable energy technologies fostering innovation and entrepreneurship. Students can explore new ideas for improving efficiency, storage, and integration of renewable energy into existing grids. This course promotes environmental stewardship by educating students about benefits of Solar Energy Technologies, Wind Energy Technologies, Hydropower and Ocean Energy, Biomass and Bioenergy and detrimental effects of fossil fuel consumption. The knowledge gained through this course will help the students to take up advanced course on different renewable energy courses in next semester.

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

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

CO-1 Classify concept of different types of renewable sources of energy and its significance.

CO-2 Explore the principles and mechanism behind solar energy conversion technologies.

CO-3 Illustrate the factors influencing wind resource variability and reliability.

CO-4 Interpret technologies for harnessing energy from ocean tides and waves, including tidal barrages, tidal turbines, and wave energy converters.

CO-5 Explore the efficiency, scalability, and environmental performance of biopower and bioheat systems compared to fossil fuel alternatives.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes(POs)							Programme SpecificOutcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	2	-	-	1	-	-		
CO-2	3	2	1	2	1	-	2		
CO-3	3	3	1	2	1	-	1		
CO-4	3	3	1	2	1	-	1		
CO-5	3	2	1	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 Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+ SL)	Total Credits (C)
		L	T				
2470301	Introduction to Renewable Energy	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)	
2470301	Introduction to Renewable Energy	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: T2470301

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain significance of different types of sources of renewable energy. *TSO 1b.* Recognize the geographical distribution of energy resources and consumption patterns worldwide. *TSO 1c.* Define renewable energy and distinguish it from non-renewable sources. *TSO 1d.* Explore the environmental advantages of utilizing renewable energy. *TSO 1e.* Examine the role of renewable energy in the broader energy mix. *TSO 1f.* Discuss broader environmental and sustainability implications beyond direct energy production.	**Unit-1.0: Renewable Energy Overview** 1.1 Overview of global energy landscape 1.2 Definition and significance of renewable energy 1.3 Environmental benefits of renewable sources. 1.4 Challenges in transitioning to renewable sources 1.5 Role of renewable sources in the energy mix integration. 1.6 Environmental and sustainability considerations.	CO1
TSO 2a. Explain Understand the principles of solar radiation and its interaction with the Earth's atmosphere. *TSO 2b.* Define photovoltaic technology and its role in converting sunlight into electricity. *TSO 2c.* Define concentrated solar power and its principles of operation. *TSO 2d.* Explore the applications, advantages, and limitations of solar thermal systems. *TSO 2e.* Examine the construction of solar panels and the materials used in their fabrication.	**Unit-2.0 Solar Energy Technologies** 2.1 Solar radiation fundamentals 2.2 Solar photovoltaic (PV) systems 2.3 Concentrated solar power (CSP) 2.4 Solar thermal technologies 2.5 Solar panel construction and materials	CO1, CO2
TSO 3a. Understand the fundamentals of wind energy generation wind energy technologies. *TSO 3b.* Define wind turbines and their primary components. *TSO 3c.* Explore the factors influencing wind resource variability and reliability. *TSO 3d.* Discuss the operation of wind energy conversion systems, including mechanical and electrical. *TSO 3e.* components. Explore factors influencing wind turbine efficiency, such as hub height, rotor diameter, and wind speed.	**Unit-3.0: Wind Energy Technologies.** 3.1 Wind Energy basics 3.2 Wind turbines and components 3.3 Wind resource assessment 3.4 Wind energy conversion systems 3.5 Wind turbine design and efficiency	CO1, CO3
TSO 4a. Understand the fundamentals of hydropower as a renewable energy source. *TSO 4b.* Define hydropower generation and its key components. *TSO 4c.* Discuss technologies for harnessing energy from ocean tides and waves, including tidal barrages, tidal turbines, and wave energy converters. *TSO 4d.* Understand the principles of ocean thermal energy conversion.	**Unit-4.0 Hydropower and Ocean Energy** 4.1 Hydropower energy basics 4.2 Principles of Hydropower generation and types 4.3 Tidal and wave energy 4.4 Ocean thermal energy conversion (OTEC) 4.5 Environmental impact and challenges.	CO1, CO4

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 4e. Identify strategies and mitigation measures for minimizing environmental harm and addressing sustainability concerns associated with ocean energy systems.		
TSO 5a. Understand the concept of biomass and its significance as a renewable energy source. *TSO 5b.* Identify biomass resources available for energy production, including forestry residues, agricultural crops, and municipal solid waste. *TSO 5c.* Discuss feedstock selection, pretreatment, fermentation, and distillation processes involved in biofuel production. *TSO 5d.* Explore the efficiency, scalability, and environmental performance of biopower and bioheat systems compared to fossil fuel alternatives. *TSO 5e.* Discuss the principles of carbon neutrality and the potential of biomass energy to contribute to carbon emission reduction goals.	**Unit-5.0 Biomass and Bioenergy** 5.1 Basics of biomass 5.2 Biomass resources and conversion processes and sources 5.3 Biofuel production processes 5.4 Biopower and bioheat generation 5.5 Sustainability and carbon neutrality.	**CO1, CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2470301

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use different types of required instrument. *LSO 1.2.* Select suitable conversion device.	1.	Convert energy units between joules, watt-hours, and kilocalories.	**CO1**
LSO 2.1. Use heat engine. *LSO 2.2.* Choose suitable method.	2.	Study the first law of thermodynamics using a simple heat enginemodel.	**CO1**
LSO 3.1. Select device as per requirement. *LSO 3.2.* Choose suitable process for calculation.	3.	Calculate the efficiency of various energy conversion devices.	**CO1**
LSO 4.1. Select suitable device for measurement. *LSO 4.2.* Use different devices related to solar irradiance	4.	Measure solar irradiance and study its variation throughout the day.	**CO2**
LSO 5.1. Choose proper device requirement. *LSO 5.2.* Operate different instruments as per requirement.	5.	Evaluate the efficiency of a small wind turbine in varying wind speeds.	**CO3**
LSO 6.1. Select proper method for calculation.	6.	Calculate the potential energy in a water source and estimate hydropower generation.	**CO3, CO4, CO5**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 6.2. Choose proper device requirement.			
LSO 7.1. Use different devices related to solar irradiance. *LSO 7.2.* Select suitable device for measurement	7.	Experiment: Determine the energy content of different biomass samples.	**CO3, CO4, CO5**
. *LSO 8.1.* Use different devices related to solar irradiance. *LSO 8.2.* Operate suitable device for measurement	8.	Test and compare the efficiency of different energy storage technologies.	**CO3, CO4, CO5**

L) Suggested Term Work and Self Learning: S2470301 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

b. Micro Projects:

1. Perform 3D Solar-Powered Phone Charger Prototype:
2. Design and build a small-scale solar-powered phone charger using photovoltaic cells and basic electronic components.
3. Demonstrate the feasibility and functionality of harnessing solar energy for personal device charging.
4. Construct a miniature wind turbine model using household materials.
5. Experiment with different blade designs and wind speeds to optimize efficiency.
6. Investigate factors affecting wind turbine performance and understand the principles of wind energy conversion.
7. Hydroponic System with Solar-Powered Pump:
8. Set up a hydroponic gardening system using recycled materials.
9. Integrate a solar panel and a small pump to circulate nutrient solution.
10. Build a simple solar water heater using readily available materials such as recycled bottles, pipes, and reflective surfaces.

c. Other Activities:

1. Seminar Topics:
    - Factors Influencing Solar Radiation Variability
    - Modeling Solar Radiation for Energy Applications
    - Recycling and Sustainability in Solar Panel Manufacturing
    - Understanding Wind Patterns and Atmospheric Dynamics
    - Performance Testing and Evaluation of Wind Turbines
    - Wind Data Analysis and Interpretation
    - Economics and Global Distribution of Hydropower Resources
    - Resource Assessment and Site Selection for Tidal and Wave Energy Projects
    - Case Studies and Pilot Projects in OTEC Development
    - Quality Control and Certification Standards for Biofuels
    - Carbon Footprint of Biomass Energy Systems: Life Cycle Assessment (LCA)

Visits:

1. Visit nearby hydropower plant station. Prepare report of visit with special comments on technique used.
2. Visit a farm or plantation to see firsthand the cultivation and harvesting of biomass feedstocks.
3. Tour a biofuel production facility to observe the processes involved in converting biomass into biofuels.

2. Self-learning topics:
   - Measure and compare the temperature increase in water exposed to sunlight versus ambient conditions.
   - Biomass Briquette Production Experiment:
   - Develop a biomass briquette using organic waste materials such as sawdust, agricultural residues, or paper.
   - Test the calorific value and combustion characteristics of the briquette compared to traditional fuels.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	-	-	20%	20%
CO-2	20%	20%	10%	25%	-	10%	20%
CO-3	20%	20%	15%	25%	33%	15%	20%
CO-4	20%	20%	30%	25%	33%	15%	20%
CO-5	25%	25%	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: Renewable Energy Overview	8	CO1	10	3	3	4
Unit-2.0 Solar Energy Technologies	10	CO1, CO2	15	3	5	7
Unit-3.0: Wind Energy Technologies.	10	CO1, CO3	15	3	5	7
Unit-4.0 Hydropower and Ocean Energy	10	CO1, CO4	15	3	5	7
Unit-5.0 Biomass and Bioenergy	10	CO1, CO5	15	3	5	7
Total	**48**	**-**	**70**	**15**	**23**	**32**

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

O) Suggested Assessment Table for Laboratory (Practical):

S.No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Convert energy units between joules, watt-hours, and kilocalories.	CO1	60	30	10
2.	Study the first law of thermodynamics using a simple heat enginemodel.	CO1	50	40	10
3.	Calculate the efficiency of various energy conversion devices. .	CO1	60	30	10
4.	Measure solar irradiance and study its variation throughout the day.	CO1, CO2	60	30	10
5.	Evaluate the efficiency of a small wind turbine in varying wind speeds.	CO1, CO3	60	30	10
6.	Calculate the potential energy in a water source and estimate hydropower generation.	CO1, CO4	60	30	10
7.	Determine the energy content of different biomass samples.	CO1, CO5	60	30	10
8.	Test and compare the efficiency of different energy storage technologies .	All	60	30	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.	Energy conversion calculator, energy meters.	(IT) = International Table,(th) = Thermochemical, https://www.generatorsource.com/Power_Calculator.aspx.	All
2.	Heat source, heat engine model, temperature sensors	DIGITAL TEMPERATURE SENSOR ,50 HZ, Sterling Engine Model(tem Code 10105)	2
3.	Equipment: Various energy devices (e.g., electric motor, generator), power meters. .	100-200 HP 200-300 KW Ac Electric Motors 3 Phase, 1500 RPM,Horsepower 100-200 HPPower 200-300 KW Speed 1500 RPM Phase Three PhaseFrame90 S	3
4.	Equipment: Solar irradiance sensor, data logger.	Solar Tracking Sensor Specifications Operating Temperature -40° to +65° C Storage Temperature -45° to +70°C Transducer Silicon photodiode Spectral Response 400 to 1100 nanometers Cosine Response Percent of Reading Percent of Full Scale ±3% (0° to ±70° Incident angle) ±10% (±70° to ±85° Incident angle) ±2% (0° to ±90°) Reference temperature 25°C	4
5.	Equipment: Small wind turbine, anemometer.	Lcd Digital Anemometers, +-(2%+0.1m/s), AVM-07 Usage/Application HVAC Process Industries Accuracy +-(2%+0.1m/s) Model Name/Number AVM-07 Display Type LCD Color NA	5
6.	Equipment: Water flow measurement tools, hydropower setup	Micro Hydro Power Plant Automation Grade Frequency 50 to 60 htz Pressure 1 kg to 10 kg Voltage 240 / 415 Surface Finish finish Grade A- one	6
7.	Equipment: Calorimeter, biomass samples	Bomb Calorimeter with Automatic Calculation Automation Grade Yes Usage/Application Briquette testing Material SS	7
8.	Equipment: Batteries, supercapacitors, energy storage systems	AS PER REQUIREMENT	All

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Fundamentals and Applications of Renewable Energy.	Mehmet Kanoglu, Yunus A.Cengel and John M. Cimbala	McGraw-Hill Education ISBN: 9781260455304
2.	Fundamentals of Renewable Energy	Shaji James P and Dipak Suresh Khatawkar	Om Publication. ISBN: 9789392590016
3.	Solar Energy	Arno Smets, Klaus Jäger, Olindo Isabella, René van Swaaij, Miro Zeman	Bloomsbury publising, ISBN: 9781906860752, 1906860750
4.	Wind Power Technology	Joshua Earnest	PHI Learning ISBN: 9788120351660, 9788120351660
5	Hydropower	Mary Boone	Capstone Pr Inc ISBN-13: 978-1543555431

(b) Online Educational Resources:

1. https://www.youtube.com/watch?v=mh51mAUexK4&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk
2. https://www.youtube.com/watch?v=iZyzvDj6Y3c
3. https://www.youtube.com/watch?v=QmQ12gSz5CY
4. https://www.youtube.com/watch?v=ETwF2xRITXs
5. https://www.youtube.com/watch?v=ANZMrVGUlvA&list=PLwdnzlV3ogoVFaDTCr-N2b_TSBPEeBJdU
6. https://www.youtube.com/watch?v=H1hrkC--dto&list=PLwdnzlV3ogoW6JKdbQWirzk3k9MeUQZFH
7. https://www.youtube.com/watch?v=NDtMMyzHFCo&list=PLwdnzlV3ogoW6JKdbQWirzk3k9MeUQZFH&index=2
8. https://www.youtube.com/watch?v=lhZNzhgPpcM&list=PLwdnzlV3ogoW6JKdbQWirzk3k9MeUQZFH&index=3
9. https://www.youtube.com/watch?v=Bw5IrRP7COs&list=PLwdnzlV3ogoW6JKdbQWirzk3k9MeUQZFH&index=4
10. https://www.youtube.com/watch?v=ckiWrC9-4PA

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. Renewal Energy Handbook
2. Lab Manuals

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

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

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

D) Rationale **:**

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

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

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

CO1- Correlate between the internal structure of materials and their properties
CO2- Interpret equilibrium phase diagrams
CO3- Select relevant Non-Ferrous metal & Anti friction alloy material for the given application
CO4- Use destructive and nondestructive testing method to test the properties of material.
CO5- Select relevant material for the given application.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

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				
2425302	Material Science and Engineering	02	01	-	02	05	04

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2425302	Material Science and Engineering	30	70	20	30	-	-	150

Legend:

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

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

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

Note:

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

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

J) Theory Session Outcomes (TSOs) and Units: T2425302

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO.1a Analyze the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF (Atomic Packing Factor), Co-ordination Number etc *TSO.1b* Explain various types of bonds with their applications *TSO.1c* Choose the suitable crystalline material for given application. *TSO.1d* Identify the defects in given crystalline materials *TSO.1e* Solve the given problems	**Unit-1.0 Introduction to Engineering Material** 1.1 Classification of materials: metals, ceramics, polymers and composites, Engineering requirements of materials, relevant properties (physical, mechanical, thermal, electrical, chemical), cost; Range of applications; Material designation and standards; Ashby diagrams; Selection criteria and process 1.2 Nature of bonding in materials: metallic, ionic, covalent and mixed bonding; structure of materials: fundamentals of crystallography, symmetry operations, crystal systems, Bravais lattices, unit cells, primitive cells, crystallographic planes and directions; structures of metals, ceramics, polymers, amorphous materials and glasses. 1.3 Defects in crystalline materials- 0-D, 1-D and 2-D defects; vacancies, interstitials, solid solutions in metals and ceramics, Frenkel and Schottky defects-dislocations, grain boundaries, twins, stacking faults; surfaces and interfaces.	**CO1**
TSO 2a. Describe major types of special steels such as HSLA, TRIP, Dual and Tool steels and cast-irons *TSO 2b.* Analyze the phase diagrams to identify the phases present in different alloy systems *TSO 2c.* Explain the structure and properties of given ferrous metals and alloys *TSO 2d.* Select relevant ferrous metal for specific applications. *TSO 2e.* Describe Standard commercial grades of steel as per BIS and AISI *TSO 2f.* Describe the basic terminologies associated with identification of phase diagrams and reactions *TSO 2g.* Solve the given problems	**Unit-2.0 Ferrous Metal & Phase Diagram** 2.1 Ferrous metals and its Alloys, Iron ores – Pig iron: classification, composition and effects of impurities on iron; Cast Iron: classification, composition, properties and uses; Wrought Iron: properties, uses/applications of wrought Iron; comparison of cast iron, wrought iron and mild steel and high carbon steel 2.2 Alloy Steels – purpose of alloying; effects of alloying elements – Important alloy steels: Silicon steel, High Speed Steel (HSS), heat resisting steel, spring steel, Stainless Steel (SS): types of SS, applications of SS – magnet steel – composition, properties and uses 2.3 Standard commercial grades of steel as per BIS and AISI 2.4 Phase diagrams- Gibbs phase rule, Degrees of Freedom, Unary phase diagram, Introduction to Binary phase diagram- Isomorphous system, Eutectic system, Eutectoid system, Iron-Carbon binary diagram, flow sheet for production of iron and steel, Application of phase diagram	**CO2**
TSO.3a Explain the structure and properties of given nonferrous metals and alloys *TSO.3b* Select relevant non-ferrous metal and anti-friction alloy for specific applications *TSO.3c* Correlate the properties of given material with its composition.	**Unit-3.0 Non-Ferrous metal & Anti Friction Alloy** 3.1 Non-ferrous metals and its Alloys – Properties and uses of aluminum, copper, tin, lead, zinc, magnesium and nickel; Copper alloys: Brasses, bronzes – composition, properties and uses; Aluminum alloys: Duralumin, hindalium, magnalium -composition, properties and uses; Nickel alloys: Inconel, monel, nichrome – composition, properties and uses 3.2 Anti-friction/Bearing alloys: Various types of bearing bronzes – Standard commercial grades as per BIS/ASME.	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO.4a Describe the various factors affecting/causing failures *TSO.4b* Select material for the given problem that can with stand catastrophic failures at different environment. *TSO.4c* Interpret the relationship between stress and strain *TSO.4d* Analyze the yielding behavior and dislocation influence on plastic deformation *TSO.4e* Determine properties of given material using different testing methods. *TSO.4f* Apply corrosion preventive techniques on the given material *TSO.4g* Describe corrosion prevention procedure for the given material. *TSO.4h* Describe coating and surface treatment procedure for the given material. *TSO.4i* Describe various methods to quantify the mechanical integrity of materials and their failure criteria *TSO.4j* Solve the given problems	**Unit-4.0 Destructive Testing and Nondestructive Testing** 4.1 Failure analysis & Testing of Materials – Introduction to failure analysis; Fracture: ductile fracture, brittle fracture; cleavage; notch sensitivity; fatigue; endurance limit; characteristics of fatigue fracture; variables affecting fatigue life; creep; creep curve; creep fracture; 4.2 Destructive testing: Tensile testing; compression testing; Hardness testing: Brinell, Rockwell; bend test; torsion test; fatigue test; creep test. 4.3 Non-destructive testing: Visual Inspection; magnetic particle inspection; liquid penetrant test; ultrasonic inspection; radiography. 4.4 Corrosion of Metal And Alloys- Mechanism of corrosion, types of corrosion, corrosion prevention technique 4.5 Surface engineering processes: Coatings and surface treatments; Cleaning and mechanical finishing of surfaces; Organic coatings; Electroplating and Special metallic plating	**CO4**
TSO.5a Select relevant material for the given problem. *TSO.5b* Evaluate the properties of given materials *TSO.5c* Identify the material from the given properties *TSO.5d* Use advanced material as per the given situation	**Unit-5.0 Advanced Material** 5.1 Polymers – Classification and applications; Polymerization techniques 5.2 Ceramics – Oxide ceramics, ceramic insulators, bio-ceramics and Glasses 5.3 Composites –Reinforcement, matrix, metal matrix composites, ceramic composites, polymer composites 5.4 Biomaterials, optical materials, high temperature materials, energy materials, and nanomaterials 5.5 Conducting and resisting materials – types, properties and applications; 5.6 Semiconducting materials – properties and applications; 5.7 Magnetic materials – Soft and hard magnetic materials and applications 5.8 Superconductors and dielectric materials – properties and applications 5.9 Smart materials-Piezoelectric, magnetostrictive and electrostrictive materials.	**CO5**

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

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

L) Suggested Term Work and Self Learning: S2425302 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

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

b. Micro project:

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

c. Other Activities:

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

2. Visits:
   - Visit nearby steel plant and prepare a detail report on the destructive and nondestructive methods used for testing and on basis of given criteria
   - Visit nearby advanced material lab and prepare a detail report on the advanced machines and equipment's with specification used for testing of ferrous, nonferrous, and advanced material.

3. Self-Learning Topics:
   - Standard commercial grades of steel as per BIS and AISI
   - Metallography
   - Material characterization

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

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

Total Marks	**30**	**70**	**20**	**20**	**10**	-	-
			50				

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

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

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

O) Suggested Assessment Table for Laboratory (Practical): (Not Applicable)

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

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

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Foundations of Materials Science and Engineering	William F. Smith Javad Hashemi Dr. Francisco Presuel-Moreno	**McGraw Hill, 2022** ISBN-10 : **9355322178** ISBN-13 : **978-9355322173**
2.	Callister's Materials Science and Engineering,	William D. Callister Jr. David G. Rethwisch	Wiley, 10 th edition, 2020 ISBN-10 : 1119453917 ISBN-13 : 978-1119453918
3.	Introduction to Materials Science for Engineers, 8e Paperback – 15 March 2020 by (Author)	James F. Shackelford	Pearson Education; 8th edition, 2020 ISBN-10 : 9353941393 ISBN-13 : 978-9353941390
4.	Kinetics in Materials Science and Engineering	Dennis W. Readey	CRC Press, 2019 ISBN-10 : **0367869837** ISBN-13 : **978-036786983**
5.	Materials Science and Engineering: Problems with Solutions	Shetty M.N	PHI Learning Private Limited ,2016 ISBN-10 : **8120351096** ISBN-13 : **978-8120351097**
6.	Mechanical Behavior of Materials	William F. Hosford	Cambridge University Press; 2nd edition, 2009 ISBN-10 : 0521195691 ISBN-13 : 978-0521195690

(b) Online Educational Resources:

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

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

(c) Others:

1. Conference paper
2. Journal paper
3. Lab Manuals

******

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

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

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

D) Rationale **:**

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

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

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

- **CO-1** Calculate direct stresses and strains in Mechanical members/components in single load situations.
- **CO-2** Determine bending moment, shear force, slope and deflection in different types of beams/ components subjected to transverse loading
- **CO-3** Calculate bending and shear stresses in different types of beams/components.
- **CO-4** Estimate shear stresses in shafts subjected to twisting moment.
- **CO-5** Calculate Stresses and deflection in helical springs.
- **CO-6** Calculate various stresses in thin pressure vessels.
- **CO-7** Calculate principal stress and strain in machine members subjected to multi-load situations.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

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				
2425303	Strength of Materials for Mechanical Engg.	03	-	04	02	09	06

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

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)	
2425303	Strength of Materials for Mechanical Engg.	30	70	20	30	20	30	200

Legend:

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

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

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

Note:

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

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

J) Theory Session Outcomes (TSOs) and Units: T2425303

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Identify various types of loadings in the given component/member with justification. *TSO 1b.* Identify mechanical components subjected to single load situations. *TSO 1c.* Calculate various elastic moduli in the given situation. *TSO 1d.* Calculate direct stresses and strains in the given determinate component/member subjected to single static longitudinal, shear and thermal loads.	**Unit-1.0 Direct Stresses and Strains in Components** 1.1 Different types of Loads. 1.2 Mechanical properties of materials like Strength, Stiffness, Hardness, Toughness, Ductility, Malleability, Elasticity, Plasticity. 1.3 Statically Determinate structures. 1.4 Direct Stress, Linear Strain, Hook's Law, Stress-Strain curve of ferrous and non-ferrous materials, Modulus of Elasticity, Yield, Proof, Breaking and Ultimate Stress and Factor of safety. 1.5 Lateral Strain and Poisson's ratio, Relations between different Moduli. 1.6 Temperature Stresses and Strain with and without yielding. 1.7 Shear Stress, Shear Strain and Shear Modulus. 1.8 Bulk Modulus and Volumetric Strain	**CO1**
TSO 1e. Identify Mechanical components subjected to bending moment. *TSO 2a.* Draw Shear Force and Bending Moment Diagram for the given Statically Determinate Beam. *TSO 2b.* Identify location of point of contra flexure in the given situation with justification. *TSO 2c.* Determine deflection and slope in a given Statically determinate Beam using given method.	**Unit-2.0 Shear Force, Bending Moment, Slope and Deflection in Beam type Components** 2.1 Types of Beams like Cantilever, Simply Supported and Over Hang Beams. 2.2 Relation between Shear Force and Bending Moment. 2.3 Sagging and Hogging Bending Moment and its importance. 2.4 Point of Contra flexure and its importance. 2.5 S.F and B.M Diagram for Cantilever, Simply Supported and Over Hang Beams. 2.6 Slope and Deflection in Cantilever and Simply Supported beams.	**CO2**
TSO 3a. Calculate the bending stress in the given beam. *TSO 3b.* Calculate Slope and Deflection in the given beam. *TSO 3c.* Calulate the shear stress behavior in the given beam.	**Unit-3.0 Bending and Shear Stresses in Beam type Components** 3.1 Bending Theory, Flexural equation, Bending stress, Bending strain, Sectional Modulus 3.2 Neutral Axis, application of Bending theory to Statically determinate beams. 3.3 Shear stress: Average and Maximum shear stress for rectangular and circular section beams. 3.4 Short members subjected to eccentric loading.	**CO3**
TSO 4a. Calculate the shear stresses in the given shaft which is subjected to pure twisting moment. *TSO 4b.* Calculate angle of twist and shear train in given solid shaft. *TSO 4c.* Calculate the power transmitted by the given solid and hollow shafts. *TSO 4d.* Select solid and hollow shaft for the given application with justification.	**Unit-4.0 Torsion of Shaft** 4.1 Torsion/Twisting Moment, Torsional Equation, Angle of Twist, Polar Moment of Inertia, Torsional Rigidity. 4.2 Torsional Stress and Strain in solid and hollow shafts. Comparison between Solid and Hollow Shafts subjected to pure torsion. 4.3 Power Transmitted /Consumed for shaft, spindle and axle of solid and hollow sections subjected to Twisting Moment.	**CO4**
TSO 5a. Calculate Stiffness, deflection and maximum stress in the given spring.	**Unit-5.0 Stresses and Deflection in Helical Springs** 5.1 Definition, types and application of springs.	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 5b. Estimate strain energy for the given axially loaded helical spring.	5.2 Spring classification based on size, shape and load-leaf spring, helical and spiral spring. 5.3 Stiffness, deflection and maximum stress in helical open and closed coil springs only.	
TSO 6a. Identify mechanical components subjected to internal/external pressure loading. *TSO 6b.* Find out various stresses induced in the given thin pressure vessel due to internal/external pressure.	**Unit-6.0 Thin Cylindrical and Spherical Pressure Vessels** 6.1 Pressure Vessels. 6.2 Thin cylinders and spheres subjected to internal pressure; Hoop stresses, longitudinal stress and change in volume. 6.3 Wire bound thin Cylindrical pressure vessels.	**CO6**
TSO 7a. Identify multi-load situations with justifications. *TSO 7b.* Estimate principal stresses and maximum shear stress for a given combined loading by analytical Approach. *TSO 7c.* Estimate principal stresses and maximum shear stress for a given combined loading by Mohr's circle method.	**Unit-7.0 Principal Stresses** 7.1 Multi load situations and need of estimating principal stresses. 7.2 Definition of principal plane and principal stresses. 7.3 Expression for normal and tangential stress, maximum shear stress. 7.4 Stresses on inclined planes. 7.5 Position of principal planes and planes of maximum shear. 7.6 Graphical solution using Mohr's circle of Stresses.	**CO7**

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

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

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use UTM to perform Tensile test. *LSO 1.2.* Plot stress-strain curve for a given material under tensile loading. *LSO 1.3.* Estimate yield strength, proof stress, ultimate strength, percentage elongation in length, percentage reduction in area. *LSO 1.4.* Use related IS Code	1.	Perform Tension Test on Mild Steel/ Aluminium on Universal Testing machine as per IS432 (I)	CO1
LSO 2.1. Use UTM to perform Compression test. *LSO 2.2.* Plot stress-strain curve for a given material under compressive loading. *LSO 2.3.* Estimate yield strength, proof stress, ultimate strength, percentage elongation in length, percentage reduction in area. *LSO 2.4.* Use related IS Code	2.	Perform Compression test on Cast Iron on Universal Testing Machine as per IS 14858	CO1
LSO 3.1. Use UTM to perform Shear test. *LSO 3.2.* Plot stress-strain curve for a given material under shear loading. *LSO 3.3.* Estimate corresponding yield strength, proof stress, and ultimate strength. *LSO 3.4.* Use related IS Code	3.	Perform direct Shear Test on Mild Steel using Universal Testing Machine as per IS 5242	CO1

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

L) **Suggested Term Work and Self Learning: S2425303** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

- Collect information about the values of different engineering properties of five standard mechanical engineering materials and present in tabular form.
- Identify simple mechanical components where single load situation exist.
- Solve numerical problems related to direct stresses and strains.
- List out different types of test that can be performed on a UTM.

- Solve numerical problems related to S.F and B.M Diagram for Cantilever, Simply Supported and Over Hang Beams type components.
- Collect information comprising of different mechanical components subjected to bending stresses.
- Prepare a list of machine components where deflection is desirable and non desirable for the functioning.
- Solve problems related to deflection of components under transverse loading.
- Solve numerical problems on simple multi load situations.

b. Micro Projects:

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

c. Other Activities:

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

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

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

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work& Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	20%	20%	20%	-	17%	50%	20%
CO-2	10%	20%	10%	33%	17%	20%	20%
CO-3	15%	15%	15%	33%	17%	-	20%
CO-4	15%	15%	15%	34%	17%	15%	20%
CO-5	10%	10%	10%	-	17%	15%	20%
CO-6	10%	10%	10%	-	15%	-	-
CO-7	20%	10%	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 percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

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

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

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

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Perform Tension Test on Mild Steel/ Aluminium on Universal Testing machine as per IS432 (I)	CO1	40	50	10
2.	Perform Compression test on Cast Iron on Universal Testing Machine as per IS 14858	CO1	40	50	10
3.	Perform direct Shear Test on Mild Steel using Universal Testing Machine as per IS 5242	CO1	40	50	10
4.	Determine Young's Modulus of Elasticity of different materials' beam simply supported at ends.	CO1, CO2	40	50	10
5.	Calculate Impact Value/Toughness of Mild Steel and Aluminium using Izod and Charpy Impact Test Apparatus as per IS 1757.	CO1	40	50	10
6.	Perform Brinell, Rockwell and Vicker's hardness test on different metals.	CO1	40	50	10
7.	Estimate Maximum Bending moment and Shear force for simply supported and cantilever beams under point load and UDL using 'Combined Shear Force and Bending Moment' apparatus.	CO2	40	50	10
8.	Measure flexural rigidity (EI) for beam using 'Slope and Deflection' apparatus and compare it with theoretical value.	CO2	40	50	10
9.	Investigate the effect of beam length and width on deflection of beam and compare it with theoretical value using 'Slope and Deflection' apparatus.	CO2	40	50	10
10.	Perform the torsion test on wire/ Rod of different materials using 'Torsion of Bar' apparatus. (Part I) as per IS 1717	CO4	40	50	10
11.	Measure Stiffness and deflection of given spring and Modulus of Rigidity of the spring wire using 'Extension and compression of Spring 'apparatus.	CO5	40	50	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

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

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

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

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
1.	Universal Testing Machine	**Universal Testing Machine:** Capacity - 40 tones. Type: Mechanical type digital, electrically Operated. Accessories: (1) Tensile test attachment for flat and round specimen up to 32 mm. (2) Compression test attachment (3) Shear test attachment with sizes of bushes (3) Shear test attachment (4) Two point and three pont bending attachment etc.	1,2,3,4,5
2.	Impact Testing Machine (Izod Test)	**IZOD Impact Test Apparatus:** Pendulum dropangle:90°-120; Pendulum effective Wt:20-25kg; Striking velocity of pendulum:3-4 m/sec; Pendulum impact energy:168 joule; Min scale graduation:2 Joule.	5
3.	Impact Testing Machine (Charpy Test)	**CHARPY Test Apparatus:** Pendulum drop angle140°; Pendulum effective Wt 20-25 kg; Strikingvelocityofpendulum5-6m/sec; Pendulum impact energy 300 j; Min scale graduation 2 J; Distance of axis of pendulum rotation from center of specimen to specimen hit by pendulum 815mm.	5
4.	Perform Brinell, Rockwell and Vicker's hardness testers	–	6
5.	Combined Shear Force and Bending Moment apparatus	Combined Shear Force and Bending Moment apparatus	7
6.	Slope and Deflection of Beam Apparatus	A bench mounted apparatus with a steel base with support at ends. The supports can be fitted with knife edges or clamp plates. A steel beam and two load hangers are together with two dial gauges for measuring beam deflections and slopes, Micrometer, Calipers, Scale, Weights and hanger.	8, 9
7.	Torsion Testing Machine	**Torsion Testing Machine:** Fixed with auto torque select or to regulate torque ranges Contains geared motor to apply torque to specimen through gearbox Attached with autographic recorder for relation between torque and angle of twist Accuracy +1% of the true torque Suitable for: Torsion and Twist test on diverse metal rods and flats, Torque Measurement by pendulum dynamometer system	10
8.	Torsions of bars apparatus	**Torsions of bars apparatus:** To understand and investigate directly the relationship between the torsional load applied to a round bar and the angular twist produced and how this relationship varies with the beam material and its cross-sectional polar moment of area. Specimens are rigidly held in a clamp fixed to one end of the bench top base frame of the apparatus.	10
9.	Extension and compression of Springs apparatus	The apparatus should be designed to be mounted on a rigid vertical support approximately 1.5 metres above floor level. It is used to test tension springs up to 200 mm in length. The maximum spring diameter is 38mm, Micrometer, Calipers, Scale, Weights and hanger.	11

R) Suggested Learning Resources:

(a) Books:

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

(b) Online Educational Resources:

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

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

(c) Others:

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

******

A) Course Code : **2470305** (**T2470305 / P2470305 / S2470305)**

B) Course Title : Solar Energy System

C) Pre- requisite Course(s) : **Fundamentals of Solar Energy**

D) Rationale :

The third semester of the Advanced Diploma in Solar Energy Systems is designed to delve deeper into the complexities of solar energy technology, focusing on advanced concepts, practical applications, and emerging trends. This semester aims to equip students with the specialized knowledge and skills required to address the evolving challenges and opportunities in the field of solar energy. By emphasizing hands-on experience and project-based learning, this course aims to prepare students for leadership roles in solar energy research, innovation, and industry.

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-6 Apply fundamentals of solar energy in solar systems.

CO-7 Assemble Photovoltaic systems with given components.

CO-8 Select suitable Solar thermal systems and thermal storage systems for given situations.

CO-9 Analyze the operation and maintenance of Solar Thermal Devices.

CO-10 Analyze the design, implementation, and management of smart grid systems.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

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				
2470305	Solar Energy System	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)	
2470305	Solar Energy System	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.

II) 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: T2470305

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1g. Explain advantages and limitations of solar energy. *TSO 1h.* Explain types and variations of radiation *TSO 1i.* Apply basic earth-sun angle relationships in solar systems *TSO 1j.* Apply the concept of Solar Constant Solar time & Equation of time, Angles for Tracking Surfaces in solar energy systems *TSO 1k.* Use pyranometers for measurement of solar radiation	**Unit-1.0 Fundamentals of Solar Energy** 1.7 Introduction to solar energy- The Sun as the source of radiation- Advantages and limitations. 1.8 Spectral Distribution of Extraterrestrial Radiation, Variation of Extraterrestrial Radiation. 1.9 Beam, Diffuse & Global Radiation. 1.10 Solar geometry, Basic Earth-Sun angles & their relationship (Simple Numerical). 1.11 The Solar Constant Solar time & Equation of time, Angles for Tracking Surfaces. 1.12 Measurement of Solar Radiation- Measurement of solar radiation using Pyranometers, Measurement of Direct, Diffuse & Global solar radiation.	CO1
TSO 2f. Explain basic principles of photovoltaic (PV) technology *TSO 2g.* Identify types of solar panels *TSO 2h.* Select suitable components for PV System. *TSO 2i.* Use maximum power condition for PV system. *TSO 2j.* Construct PV Panel, Cell, Module, Array *TSO 2k.* Classify PV system *TSO 2l.* Apply principles of PV technology *TSO 2m.* Mount and install PV system *TSO 2n.* Maintain and troubleshoot common issues in PV systems. *TSO 2o.* Practice safety measures for maintenance and repair activities.	**Unit-2.0 Solar Photovoltaic System** 2.1 Basic principles of photovoltaic (PV) technology- Types of solar panels and their characteristics 2.2 Solar PV System Components- Overview of PV system components (panels, inverters, charge controllers, batteries), Function and selection criteria for each component, 2.3 Maximum power condition of PV system. 2.4 Formation of PV Panel, Cell, Module, Array, Balance of System (BOS). 2.5 Classification of PV system: Stand-alone solar PV System, Grid Interactive Solar PV System, Hybrid Solar PV System, Centralized and De-Centralized Systems. 2.6 Solar PV Applications: Principles & components of Grid Interactive Solar PV Power Generation, Solar Water Pumping system, Street Lighting, 2.7 Mounting structures and installation of PV system- Safety measures in PV system installations 2.8 Maintenance and Troubleshooting- Routine maintenance procedures for PV systems, Troubleshooting common issues in PV systems, Safety protocols during maintenance and repair activities	CO1, CO2
TSO 3f. Classify solar collectors. *TSO 3g.* Select materials used for solar collectors. *TSO 3h.* Explain terminologies related to solar collectors. *TSO 3i.* Apply basic energy balance equation for the basic flat-plate solar collector.	**Unit-3.0 Solar Thermal Systems and Thermal Storage System** 3.6 Solar Collectors- Liquid Flat-Plate Collectors – Materials required, Collector efficiency, Overall heat loss coefficient, Bottom loss coefficient, Top loss coefficient, Side loss coefficient, Sky temperature.	CO1, CO3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3j. Examine temperature distribution in flat-plate collectors. *TSO 3k.* Identify factors for improvement of collector efficiency. *TSO 3l.* Explain basic principle of evacuated tube collector and concentrating collector. *TSO 3m.* Describe about Cylindrical Parabolic Collector, Compound Parabolic Collector (CPC), Paraboloid Dish Collector, Central Receiver Collector. *TSO 3n.* Identify battery storage technologies for specific usage. *TSO 3o.* Explain characteristics and performance of batteries.	3.7 Basic Flat-Plate Energy Balance Equation. Temperature distribution in Flat-Plate Collectors, Collector Heat removal Factor and Flow Factor, Improvement of collector efficiency. 3.8 Evacuated tube collector – Basic principle, construction. 3.9 Solar Concentrating Collector – Classification, Parameters of solar concentrators, Concentration Ratio, Thermal Performance of Concentrating Collectors. 3.10 Introduction to Cylindrical Parabolic Collector, Compound Parabolic Collector (CPC), Paraboloid Dish Collector, Central Receiver Collector. 3.11 Battery Technologies for Energy Storage- Different types of batteries used in solar energy systems- Lead Acid, Nickel Cadmium, Li-ion, Zinc Manganese dioxide. Characteristics and performance of batteries.	
TSO 4f. Classify air heaters. *TSO 4g.* Explain the working principle of Simple SAH. *TSO 4h.* Differentiate between collector with Non-porous absorber, Collector with porous absorber. *TSO 4i.* Explain Solar Water Heating System *TSO 4j.* Explain the working of Swimming Pool Heating. *TSO 4k.* Identify different types of Solar Cooker. *TSO 4l.* Explain the working of a Solar Cooker. *TSO 4m.* Explain the working of a Solar Dryer. *TSO 4n.* Explain the working of a Solar Still.	**Unit 4.0 Solar Thermal Devices-** 4.1 Solar Air Heater (SAH) – Types of Air Heaters, Working Principle of Simple SAH. 4.2 Collector with Non-porous absorber, Collector with porous absorber. 4.4 Solar Water Heating System, Forced-Circulation and Natural circulation. 4.1 Swimming Pool Heating. 4.2 Solar Cooker – Types, Basic principle. 4.3 Box type solar cooker – Design, Construction and Performance. 4.4 Paraboloid type solar cooker 4.5 Solar Dryers – Types, Basic principle, Cabinet type Dryer & Indirect Dryer, Applications. 4.6 Solar still – Basic principle, Components required, Schematic diagram, Applications.	**CO1, CO3, CO4**
TSO 5f. Explain the basics of smart grid integration *TSO 5g.* Differentiate between Conventional Grid and Smart Grid *TSO 5h.* Identify the concepts of a resilient grid. *TSO 5i.* Recognize the role of smart meter in smart grid. *TSO 5j.* Recognize the role of smart appliances in smart grid.	**Unit-5.0 Smart Grid Integration** 5.1 Definition, need, and function of Smart Grid. 5.2 Opportunities and Barriers of Smart Grid. 5.3 Difference between Conventional Grid and Smart Grid 5.4 Concept of Resilient Grid and Smart Grid. 5.5 Role of Smart Meter in Smart Grid.	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 5k. Investigate the integration of solar energy with other renewable technologies. *TSO 5l.* Analyze hybrid renewable energy systems for enhanced reliability and resilience.	5.6 Smart Appliances- Automatic Meter Reading (AMR), Smart Sensors. 5.7 Integration of Solar Energy with Other Renewable Technologies- Investigate the integration of solar energy with other renewable technologies, such as wind, hydropower, and geothermal energy. 5.8 Analyze hybrid renewable energy systems for enhanced reliability and resilience.	

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2470305

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.3. To understand the principles of solar radiation measurement using a pyranometer. *LSO 1.4.* To differentiate between beam, diffuse, and global radiation components. *LSO 1.5.* To learn the procedure for conducting solar radiation measurements on horizontal and tilted surfaces. *LSO 1.6.* To analyze and interpret the characteristics of solar radiation over a specified duration.	1.	Experiment to measure beam, diffuse and global radiation on horizontal/tilted surface using Pyranometer and plot radiation vs. time characteristics for certain duration.	**CO1**
LSO 1.7. To identify common problems and malfunctions that can occur in solar PV panels and arrays.	2.	Troubleshoot solar PV panel and arrays and identify its remedy.	**CO2,**
LSO 1.8. To identify different components of solar street lighting system for DC/AC supply.	3.	Identify different components of solar street lighting system for DC/AC supply.	**CO2**
LSO 2.3. To identify the different parts of a solar flat plate collector.	4.	Study the different parts of a solar flat plate collector.	**CO3**
LSO 3.3. To analyze factors affecting thermal efficiency *LSO 3.4.* To identify areas for improvement in the solar air heater design or operation.	5.	Experiment for thermal performance test of solar air heater.	**CO3, CO4**
LSO 4.3. To identify different parts of an evacuated tube collector.	6.	Study of different parts of an evacuated tube collector.	**CO3**
LSO 6.3. Produce single plastic components using available 3D printer. *LSO 6.4.* Perform post processing operations on printed component.	7.	Study of different parts of a solar concentrating collector.	**CO3**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 8.3. Analyze the impact of different reflector configurations on the efficiency of a solar cooker. *LSO 8.4.* Collect and interpret experimental data to evaluate the thermal performance of the solar cooker under varying conditions.	8.	Experiment to measure thermal performance of a solar cooker with varying reflector	**CO3, CO4**
LSO 10.1. Identify and measure key parameters of a solar dryer, including temperature, humidity, airflow rate, and drying rate. *LSO 10.2.* Analyze experimental data to evaluate the performance and efficiency of the solar dryer under varying conditions. *LSO 10.3.* Apply knowledge of solar drying principles to propose optimizations for enhancing the efficiency and effectiveness of solar dryers.	9.	Experiment to measure the parameters of a solar dryer.	**CO4**
LSO 11.1. Operate pyranometers proficiently to measure direct, diffuse, and global solar radiation components accurately. *LSO 11.2.* Analyze collected data to differentiate between direct, diffuse, and global solar radiation and understand their variations over time. *LSO 11.3.* Interpret the significance of direct, diffuse, and global solar radiation components in various applications, including solar energy systems and climate studies. *LSO 11.4.*	10.	Measurement of solar radiation using Pyranometers, Measurement of Direct, Diffuse & Global solar radiation.	**CO1**
LSO 11.1. Operate instruments proficiently to measure and record solar radiation data accurately. *LSO 11.2.* Analyze collected data to determine the duration of sunshine hours, average solar radiation, and clear sky radiation under varying atmospheric conditions. *LSO 11.3.* Interpret the distribution of solar radiation parameters on clear and cloudy days and understand their implications for renewable energy applications, weather forecasting, and climate studies. *LSO 11.4.*	11.	Measurement of duration of Sunshine hours, Average Solar Radiation, Clear Sky Radiation, Clear and Cloudy days and its distribution.	**CO1**
LSO 11.1. Operate instruments proficiently to measure solar radiation on inclined surfaces accurately.	12.	Measurement of Radiation on inclined surfaces, Ratio of Beam radiation on Tilted surface to that on Horizontal surface.	**CO1**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 11.2. Calculate the ratio of beam radiation on a tilted surface to that on a horizontal surface using measured data. *LSO 11.3.* Interpret the significance of the ratio of beam radiation for optimizing the orientation of solar energy systems and predicting their performance under different tilt angles.			

L) Suggested Term Work and Self Learning: S2470305 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

e. Micro Projects:

1. Solar Water Heating System Design:
   Objective: Design a solar water heating system for a residential building.
   Tasks:
   Conduct a site survey to assess solar resource availability and identify suitable locations for solar collectors.
   Select appropriate solar collector type (e.g., flat plate, evacuated tube) based on local climate and hot water demand.
   Design the system layout, including collector placement, piping configuration, and thermal storage capacity.
   Calculate system performance metrics such as solar fraction and annual energy savings.
   Create a detailed design report including component specifications, system diagrams, and cost analysis.
2. Solar Photovoltaic (PV) System Installation:
   Objective: Install a grid-tied solar PV system on a rooftop or ground-mounted platform.
   Tasks:
   Perform a site assessment to determine optimal PV system size, orientation, and tilt angle.
   Select appropriate PV modules, inverters, mounting structures, and balance of system components.
   Install PV modules and mounting hardware according to manufacturer specifications and local building codes.
   Configure inverters, electrical wiring, and monitoring systems to ensure proper system operation.
   Test and commission the PV system, including performance verification and safety checks.
3. Solar Charger Design for Portable Devices:
   Objective: Design a portable solar charger for charging mobile phones or other electronic devices.
   Tasks:
   Select suitable solar panels and charge controller based on device charging requirements and portability.
   Design a compact and lightweight enclosure for housing solar panels, battery storage, and charging circuitry.
   Integrate USB or other charging ports and indicators for user interface and feedback.
   Test the solar charger prototype under different sunlight conditions to assess charging performance and efficiency.
   Optimize the design for cost-effectiveness, durability, and ease of use.
4. Solar Tracker Construction:
   Objective: Build a solar tracker to maximize solar energy capture by continuously adjusting the orientation of solar panels.
   Tasks: Research different solar tracker designs and mechanisms, such as single-axis and dual-axis trackers.
   Select appropriate materials and components for constructing the solar tracker frame, actuators, and control system.
   Assemble and test the solar tracker prototype, ensuring smooth and accurate movement in response to solar position changes.

Evaluate the performance of the solar tracker compared to fixed-tilt solar panels in terms of energy yield and efficiency.

Document the construction process, including design drawings, assembly instructions, and performance data.

5. Solar Energy Monitoring and Data Analysis:

Objective: Develop a solar energy monitoring system to collect, analyze, and visualize real-time data from solar energy systems. Tasks:

Select sensors and data loggers for measuring solar radiation, temperature, PV system output, and environmental conditions.

Design and implement a data acquisition system to capture sensor readings at regular intervals.

Develop software for data processing, storage, and visualization using tools such as Python, MATLAB, or IoT platforms.

Deploy the monitoring system to collect data from multiple solar energy installations over an extended period.

Analyze collected data to assess system performance, identify trends, and optimize operation for maximum energy efficiency.

f. Other Activities:

3. Seminar Topics:
    - A discussion on solar thermal energy conversion technologies, such as solar water heating systems, concentrating solar power (CSP) plants, and solar air heaters.
    - An overview of net metering and feed-in tariff (FIT) policies for incentivizing solar energy generation and promoting renewable energy integration into the grid
    - A review of solar energy storage options, including battery storage systems, thermal energy storage, and pumped hydro storage, and their role in enabling solar energy dispatchability.
    - A case study on the implementation of solar energy systems for rural electrification projects, including off-grid PV systems, microgrids, and community-based solar initiatives.
    - An overview of recent advancements and emerging trends in solar energy technologies, such as bifacial solar panels, perovskite solar cells, floating solar PV, and solar-powered desalination.

4. Visits: Visit nearby solar panel manufacturing facility and draw valuable insights into the entire process of solar panel production, from raw materials to finished products.

5. Self-learning topics:
    - Explore different types of solar PV modules, such as monocrystalline, polycrystalline, and thin-film, and compare their characteristics, efficiency, and applications.
    - Study the various components of a solar PV system, including solar panels, inverters, charge controllers, batteries, and mounting structures, and understand their functions and interactions.
    - Explore best practices for installing and maintaining solar PV systems, including site assessment, mounting techniques, wiring, testing, troubleshooting, and routine maintenance tasks.
    - Study national and regional policies, regulations, and incentives related to solar energy deployment, including net metering, feed-in tariffs, tax credits, and renewable energy targets.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	-	-	20%	20%
CO-2	10%	10%	10%	25%	-	10%	20%
CO-3	15%	15%	15%	25%	33%	15%	20%
CO-4	30%	30%	30%	25%	33%	15%	20%
CO-5	30%	30%	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 Fundamentals of Solar Energy	10	CO1	14	4	5	5
Unit-2.0 Solar Photovoltaic System	10	CO1, CO2	14	4	5	5
Unit-3.0 Solar Thermal Systems And Thermal Storage System	10	CO1, CO3	14	4	6	4
Unit-4.0 Solar Thermal Devices	10	CO1, CO3, CO4	16	4	6	6
Unit-5.0 Smart Grid Integration	8	CO5	12	4	4	4
Total	**48**	**-**	**70**	**20**	**26**	**24**

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** (%)	
9.	Experiment to measure beam, diffuse and global radiation on horizontal/tilted surface using Pyranometer and plot radiation vs. time characteristics for certain duration.	CO1	30	60	10
10.	Troubleshoot solar PV panel and arrays and identify its remedy. Identify different components of solar street lighting system for DC/AC supply.	CO1	40	50	10
11.	Identify different components of solar street lighting system for DC/AC supply.				
12.	Study the different parts of a solar flat plate collector.	CO1	30	60	10
13.	Experiment for thermal performance test of solar air heater.	CO2	30	60	10
14.	Study of different parts of an evacuated tube collector.	CO3, CO4, CO5	30	60	10
15.	Study of different parts of a solar concentrating collector.	CO3, CO4, CO5	30	60	10
16.	Experiment to measure thermal performance of a solar cooker with varying reflector	CO3, CO4, CO5	30	60	10
17.	Experiment to measure the parameters of a solar dryer.	CO3, CO4, CO5	40	50	10
18.	Measurement of solar radiation using Pyranometers, Measurement of Direct, Diffuse & Global solar radiation.	CO4, CO5	40	50	10
19.	Measurement of duration of Sunshine hours, Average Solar Radiation, Clear Sky Radiation, Clear and Cloudy days and its distribution.	CO5	40	50	10
20.	Measurement of Radiation on inclined surfaces, Ratio of Beam radiation on Tilted surface to that on Horizontal surface.	CO5	30	60	10

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

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

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

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

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	High end computers	Processor Intel Core i7 with Open GL Graphics Card, RAM 32 GB, DDR3/DDR4, HDD 500 GB, Graphics Card NVIDIA OpenGL 4 GB, OS Windows 10	All
2.	Solar Energy Trainer Kit	Solar panel : 160 Watt x 2nos.(Total 320 Watts) Battery : Upto 100AH Charger controller: (PWM basedMPPT) Charging stage: Bulk, Absorption& Float Inverter :600VA DC Voltmeter :0~200V DC (02 Nos.) DC Ammeter :0~100 A DC (02 Nos.) Multifunction Meter: Voltage, Current, Watt & Frequency Load : Rheostat with additional provision for external load MCB for Circuit Protection - 02Nos. BS 10 Connectors for making the Solar & Battery Connection : 02 Nos. Power Requirement: 220 VAC +10%,50Hz	
3.	Solar Flat Plate Collector		
4.	Evacuated tube collector		
5.	Solar inverter system		
6.	Solar cooker		
7.	solar dryer		
8.	Solar water pump		
9.	Solar street lighting system 9watts		
10.	Pyranometer, solarimeter		

R) Suggested Learning Resources:

(b) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Solar thermal energy storage Book	H. P Garg.	Springer ISBN-10 : 9401088411 ISBN-13 : 978-9401088411
2.	Solar Energy: Principles of Thermal Collection and Storage Book	Suhas Panduran Sukhatme.	McGraw-Hill Inc. ISBN-10 : 0074519468 ISBN-13 : 978-0074519462
3.	Design of Solar Thermal Power Plants Book	Zhifeng Wang.	Academic Press ISBN : 0128156139
4.	Modeling and Optimization of Solar Thermal Systems: Emerging Research and Opportunities Book	Agnimitra Biswas.	Business Science Reference ISBN-10 : 1799835235 ISBN-13 : 978-1799835233
5.	Solar Water Heating: A Comprehensive Guide to Solar Water and Space Heating Systems Book	Bob Ramlow.	New Society Publishers ISBN-10 : 0865716684 ISBN-13 : 978-0865716681

(b) Online Educational Resources:

11. https://youtu.be/BWqjPHGM5D0?si=XcQG1Tw1CWsi_FQX
12. https://archive.nptel.ac.in/content/storage2/courses/112105050/m1l1.pdf
13. https://youtu.be/sh4ZjiVlRC4?si=Zf-3DhHEQsuCcmS0
14. https://youtu.be/0FSEKHc-COA?si=seHWeXY-KQAwPFyP
15. https://youtu.be/Q_OdV8m6cqk?si=uyFnW7jve-TeM5YY

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:

3. Solar Engineering of Thermal Processes" by John A. Duffie and William A. Beckman
4. Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy" by Michael Boxwell
5. Coursera: "Solar Energy Basics" by Delft University of Technology3D Printer Users' Guide
6. edX: "Solar Energy: Photovoltaic (PV) Systems" by Delft University of Technology
7. https://mnre.gov.in/

******

A) Course Code : 2425306 (P2425306/S2425306)

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

C) Pre- requisite Course(s) :

D) Rationale :

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

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

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

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

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

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2425306	Summer Internship -I	-	-	02	02	04	02

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2425306	Summer Internship -I	-	-	10	15	10	15	50

Legend:

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

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

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

Note:

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

I) Suggested Instructional/Implementation Strategies: Mentors/ Coordinators/ Teachers need to plan and implement the summer internship in their respective programme as per the outcome expected from the programme. However, in general, summer internship would help in exploring and exposing the student to the below mentioned dimensions of the world of work. These dimensions can further be explored in depth as per the need and advancement in respective programmes in later stages. Mentors/Coordinators/ Teachers need to map the academic contents of the programme of study with the activities of this industrial exposure and are advised to follow the whole to part approach to make the students aware about the

potential industry's expected outcomes & setup ('Whole') from the specific diploma programme and then teaching the related concepts ('Part') of the same in subsequent semesters.

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

J) Assessment of Summer Internship -I

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

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

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A) Course Code **: 2400207 (T2400207 / S2400207)**

B) Course Title **:** Indian Constitution (Common for all Programmes)

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

D) Rationale **:**

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

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

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

CO-1 Enumerate salient features and characteristics of the constitution of India.

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

CO-3 Analyze major constitutional amendments in the constitution.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400207	Indian Constitution	01	-	-	-	01	01

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400207	Indian Constitution	25	-	25	-	-	-	50

Legend:

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

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

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

Note:

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

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

J) Theory Session Outcomes (TSOs) and Units: T2400207

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

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

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

L) Suggested Term Work and Self Learning: S2400207

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

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

b. Micro Projects:

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

c. Other Activities:

1. Seminar Topics:
- Democracy and Political Participation in India
- Situations where directive principles prevail over fundamental rights.

2. Visits:
    - Arrange Mock Parliament.

3. Design games and simulation on emergencies declared in last thirty years.

4. Group discussions on current print articles.
    - Adoption of Article 365 in India.
    - Need of amendments in the constitution.

5. Prepare collage/posters on current constitutional issues.
    - Emergencies declared in India
    - Seven fundamental rights

6. Cases: Suggestive cases for usage in teaching:

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

7. Self-Learning Topics:

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

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

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

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

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

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

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

R) Suggested Learning Resources:

(a) Books:

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

(b) Online Educational Resources:

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

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

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A) Course Code : **2400108 (T2400108)**

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

C) Pre- requisite Course(s) :

D) Rationale :

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

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

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

CO-1 Identify the rich heritage and legacy residing in our Indian Knowledge systems.

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

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400108	Essence of Indian Knowledge System and Tradition	01	-	-	-	01	01

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)	
2400108	Essence of Indian Knowledge System and Tradition	25	-	-	-	-	-	25

Legend:

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

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

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

Note:

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

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

J) Theory Session Outcomes (TSOs) and Units: T2400108

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

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

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

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

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

b. Micro Projects:

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

c. Other Activities:

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

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

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

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

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

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

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

R) Suggested Learning Resources:

(a) Books:

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

(b) Online Educational Resources:

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

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

(c) Others:

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

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

B) Course Title **:** Community/ Society Development
(AIML, AE, CSE, ELX (R), CHE, EE, ME, ME (Auto), MIE, FTS, CACDDM, FPP)

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

D) Rationale **:**

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

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

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

CO-1 Identify the issues and problems faced by local communities/societies that can be addressed through community development schemes for sustainable development.

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

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Course Title	Scheme of Study (Hours/Week)				
	Classroom Instruction (CI)		Notional Hours (TW/ Activities+ SL)	Total Hours (CI+TW/ Activities)	Total Credits (C)
	L	T			
Community/ Society Development	01	-	-	01	01

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400110	Community / Society Development	25	-	-	-	-	-	25

Legend:

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

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

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

Note:

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

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

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

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

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

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

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

b. Micro Projects:

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

c. Other Activities:

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

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

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

L) 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.

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

N) Suggested Learning Resources:

(a) Books and Reports:

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

(b) Online Edu

(c) cational Resources:

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

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

(c) Others:

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

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